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THE OTOLOGIST AND THE HEARING AID — FREDERICK R. GUILFORD, M.D., ET AL.

SUBJECTIVE CUPULOMETRY — G. v. BEKESY, Ph.D.

ACUTE OBSTRUCTION OF THE UPPER RESPIRATORY TRACT — DONALD E. McDOWELL, M.D., ET AL.

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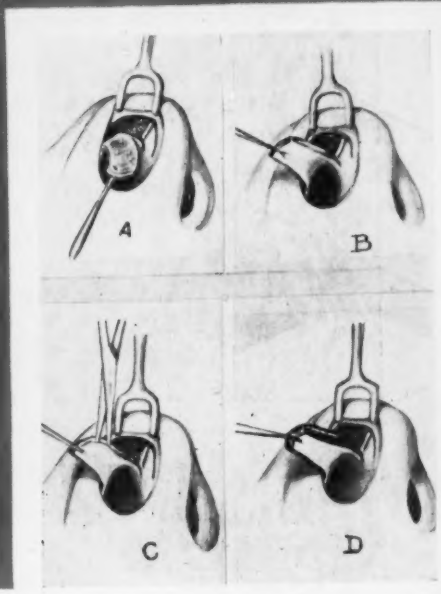

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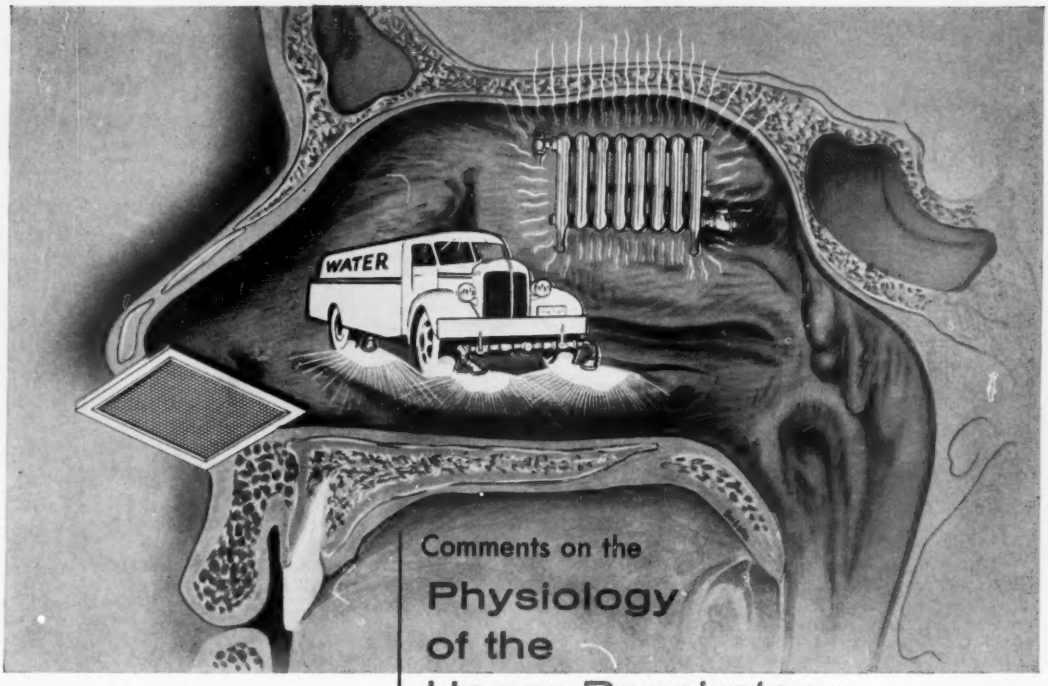

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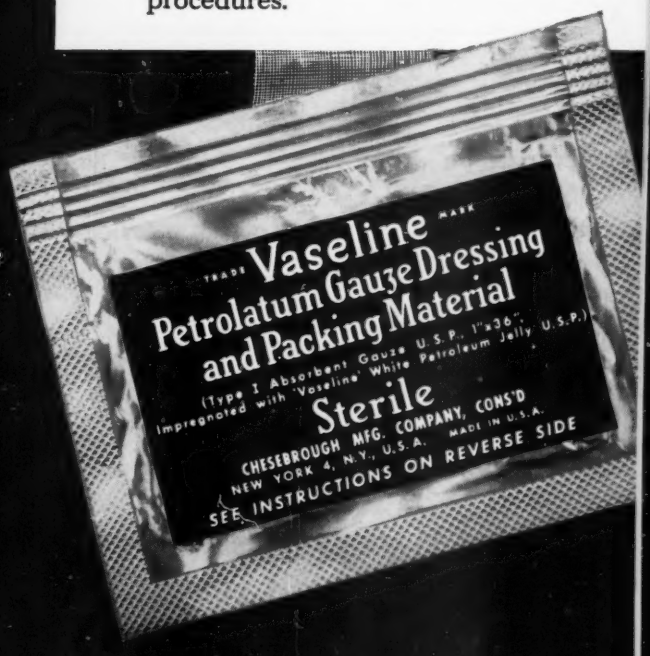
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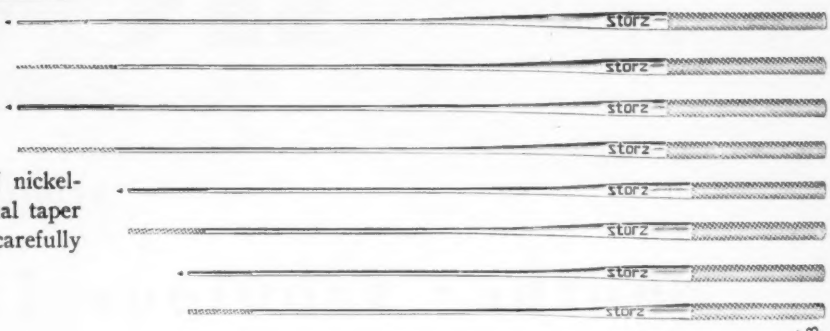

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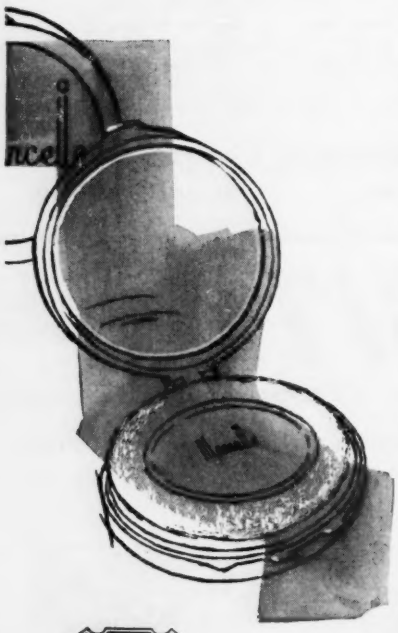

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Editorial

LETTER FROM THE EDITORS

WE HOPE that you will like the "new look" of the ARCHIVES. The cover has been completely redesigned, and illustrations and space have been rearranged to present a maximum amount of material in the minimum compass compatible with good readability. If you disapprove, the editors accept a full share of responsibility for these changes, because they were consulted freely during the planning. The editors were somewhat disturbed by the fact that this is the second change in the format of the ARCHIVES since its publication began, in 1925. However, they were glad to accede to the new proposals for the cover, provided it contained at least a partial list of the table of contents, a suggestion which was readily accepted by the business management.

It has been felt, in line with the policy of the Editorial Board to attempt to keep abreast of the major interest of all otolaryngologists by such innovations as the Scientific Exhibits, editorials on timely topics, etc., some change in the physical form of the ARCHIVES was in order. The Editorial Board agrees and feels that the changes made are well conceived and executed. The editors will strive to continue to do their part in selecting new, reliable, and informative material for the readers and in presenting it without undue delay.

CHIEF EDITOR

STENOSIS OF THE ESOPHAGUS AND STOMACH FOLLOWING THE INGESTION OF CORROSIVE SUBSTANCES

COLONEL BYRON G. McKIBBEN and MAJOR SAMUEL LEE, Medical Corps, United States Army

PYLORIC obstruction may result from the swallowing of corrosive substances. It is not generally known that this complication may occur.

When alkalies or acids are taken into the mouth in sufficient concentration, the appearance of a burn about the mouth may be noted; and if these substances are swallowed, the whole alimentary tract may become involved, and marked corrosion and perforation may result. If the patient survives the immediate effects, there usually results fibrosis of the esophageal and gastric mucosa, with subsequent choking-off of the gastric glands and altered digestion.[1] If this fibrosis is severe enough, stricture results, and the severity of the stricture is dependent upon the extent and depth of the fibrosis. Cicatricial areas in a large lumen, such as the fundus of the stomach, may cause no obstruction, whereas the same amount of scarring in a narrow lumen, such as the esophagus or pylorus, may cause marked obstruction.

Acids damage mainly the tissues of the stomach, while alkalies exert most of their injurious effects on the esophagus.[2]

Cicatricial pyloric obstruction due to the ingestion of alkali has been occasionally reported in patients who also had an esophageal stricture. It has occurred, however, in patients who had no associated esophageal lesion.[2] Vinson and Hartman [3] stated that the swallowing of a solution of lye almost always results in a burn of the esophagus severe enough to produce a stricture and that if the quantity swallowed is sufficiently large (as in suicidal attempts) a burn of the stomach severe enough to cause a stricture at the pylorus may result.

Acids usually spare the esophagus and attack the stomach, and in nearly all cases in which they cause stricture of the esophagus they produce also an associated obstruction of the pylorus. There may be exceptions, however, such as reported by Vinson,[4] Kearney,[5] and Trainer,[6] each of whom related an unusual case wherein the ingestion of a caustic acid caused stenosis of the esophagus but did not produce any pyloric obstruction.

Bolstad [7] in 1948 reported two cases of pyloric obstruction associated with stricture of the esophagus following the ingestion of lye, and called attention to the fact that, although medical literature makes frequent reference to esophageal stricture following the ingestion of alkalies and to pyloric obstruction following the ingestion of acids, the finding of the two lesions in the same patient caused by the ingestion of either of these two caustics was apparently uncommon.

Gray and Holmes [8] in 1948 reviewed the literature as far back as 1882 and found 139 cases in which pyloric stenosis followed the ingestion of some corrosive. Only 11 of these cases were reported by American authors. The most commonly reported corrosive agent causing pyloric obstruction is hydrochloric acid, although sulfuric acid is more readily available. The explanation for this is that the number of persons who die of edema of the glottis, perforation, gangrene, and collapse soon after the swallowing of sulfuric acid is significantly higher than is the number of persons who die of similar causes soon after the swallowing of hydrochloric acid. As a result, comparatively few persons who ingest sulfuric acid live long enough for pyloric obstruction to develop.

From the Otolaryngology Service, Department of Surgery, Letterman Army Hospital, San Francisco.

Fig. 1 (Case 1).—Roentgenogram three weeks after the ingestion of lye. Diffuse stricture of the esophagus beginning at the level of the aortic arch and extending to the cardia.

Gray and Holmes' review of the literature brought to light the following interesting statistics:

1. In one series of 52 cases and another series of 34 cases of pyloric obstruction secondary to the ingestion of acids, esophageal strictures of some degree were also present in approximately 20% of the cases in each of these two series.

2. In one series of 116 cases of esophageal stricture secondary to the ingestion of lye (sodium hydroxide), pyloric stenosis was also present in 20% of the cases.

3. There were 10 random cases in which the ingestion of caustic alkali resulted in stenosis of both the esophagus and pylorus.

4. There were four random cases in which the ingestion of caustic alkali resulted in stenosis of the pylorus and failed to damage the esophagus.

In contrast to Gray and Holmes' conclusion that 20% of cases that ingest corrosive alkalies will develop pyloric stenosis, medical literature contains many series of cases of esophageal stenosis following the ingestion of caustic alkalies in which there is no mention of concomitant pyloric stenosis.*

It is not the purpose of this paper to give a complete review of the literature or to present a comprehensive thesis on chemical burns of the gastrointestinal tract. For this the reader is referred to the many excellent presentations in medical literature, a few of which are listed in our references.

REPORT OF CASES

CASE 1.—A 56-year-old white woman on March 24, 1953, attempted suicide by swallowing several pieces of chocolate candy in which she had placed some household lye. This produced some epigastric distress but no other symptoms. Two days later, she took one swallow of a solution of lye, which caused immediate burning of the mouth and throat, followed by regurgitation of brownish mucus. On arrival at the hospital, she was unconscious; the blood pressure was 75 mm. of mercury systolic and 60 mm. diastolic. A few thick rhonchi were heard in both lung fields. There were burns of the palate and fauces. Gastric lavage was performed in the emergency room, and she was admitted to the hospital.

Cortisone (Cortone) acetate, penicillin, and streptomycin were prescribed, and a Levin tube was passed into the stomach.

On April 1, a gastrointestinal series suggested some narrowing of the esophagus, and gastritis without evidence of ulceration. On the five-hour examination approximately 50% of the barium remained in the stomach.

* References 9 to 14.

Fig. 2 (Case 1).—Roentgenogram eight weeks after the ingestion of lye. *E*, stenosed distal portion of esophagus; *P*, stenosed pars media and pyloric antrum of the stomach.

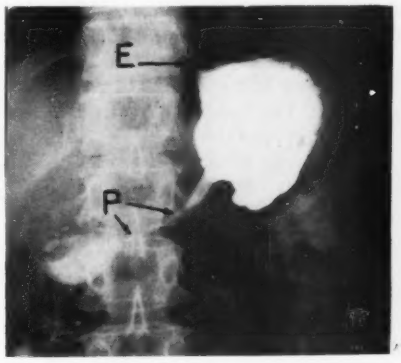


Fig. 3 (Case 2).—Roentgenogram 12 days after the ingestion of Drano.

By April 10, she was able to take a soft diet, the Levin tube was removed, and she was discharged from the hospital the next day.†

On admission to the Otolaryngology Service, Letterman Army Hospital, April 13, 1953, her general physical examination was normal. Blood pressure was 120 mm. of mercury systolic and 80 mm. diastolic. Her weight was 135 lb. (61 kg.). Both piriform sinuses were filled with secretion. She was able to swallow liquids and soft foods. Fluoroscopic examination and x-ray films with an opaque meal revealed marked stricture of the esophagus, beginning at the aortic arch and extending to the cardia. The distal esophagus was no greater than 3 mm. in diameter (Fig. 1). Unfortunately, x-ray examination of the stomach was not done at this time.

A perforated lead shot was attached to the end of a No. 3 braided silk thread, and, with considerable difficulty, it was swallowed into the stomach.

On April 17, esophagoscopy revealed inflammation of the upper third of the esophagus, and at about the junction of the upper and middle thirds, granulations became so extensive and the lumen so stenosed that further passage of the esophagoscope was impossible. Passage of flexible-end Chevalier Jackson bougies up to No. 18 F. was accomplished. The last bougie met slight resistance and, when withdrawn, was blood-tinged.

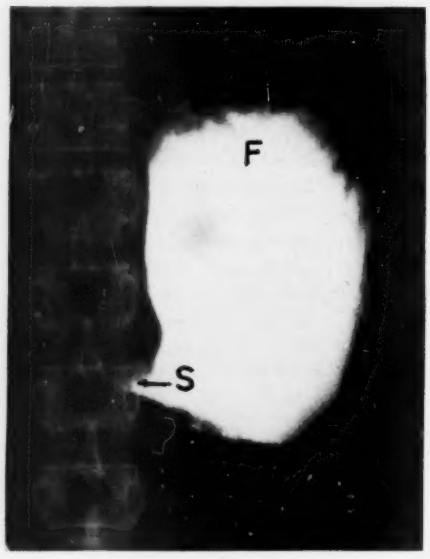
A Levin tube was passed into the stomach, and she was placed on a high caloric, high vitamin diet.

By April 30 the thread was well anchored in the intestinal tract and could be drawn taut enough for guided dilatations with the Jackson-Plummer esophageal dilators. By May 18, dilatation had progressed to a No. 31 F. bougie, at which time the thread broke.

She was experiencing increased frequency of emesis, had lost 35 lb. (16 kg.), and was unable to swallow the thread beyond the stomach. Because of this, pyloric obstruction was suspected.

On May 19, fluoroscopic examination and x-ray films with a barium meal revealed no apparent change in the esophagus. There was marked stricture of the pars media and pyloric antrum of the stomach, and the possibility of a neoplasm as an independent lesion could not be ruled out (Fig. 2). Dilatations were then continued with Hurst mercury-filled esophageal bougies.

Fig. 4 (Case 2).—Roentgenogram six weeks after the ingestion of Drano (sodium hydroxide). *F*, dilated fundus of stomach; *S*, strictured pyloric antrum. Other films in this series revealed that the obstruction was almost complete. Only a mere trickle of barium passed through the stenosed area.



† Clinical abstract of first hospitalization was received May 30, 1953.

On May 28, an anterior gastroenterostomy ‡ was performed. Examination of the stomach at time of surgery revealed the distal two-thirds to be markedly constricted, giving the appearance of a tubular structure. It was woody in texture, and the serosa was injected. The wall of the proximal third was almost twice as thick as that of a normal stomach, and the mucosa was pale.

Histopathological examination of tissue removed from the proximal third of the stomach revealed that the mucosa and submucosa had undergone extensive necrosis and replacement by granulation tissue. In some sections the mucosal glands were almost absent. The muscularis mucosa and submucosa showed a dissolution of their normal structure. All layers of the muscularis appeared intact and relatively uninvolved. There was no evidence of malignancy.

Esophageal dilatations were again resumed on June 8, and by June 25 she was able to pass, without local anesthesia, a No. 40 Hurst mercury-filled bougie. She continued to pass this bougie at weekly intervals for two months, then three times monthly for six months.

She failed to return for follow-up, but information was received that she had gained weight and was getting along very well.

Comment.—During the patient's first hospitalization:

1. Esophagoscopy was not performed. This should be done as soon as the acute inflammatory reaction has subsided and the patient is able to take liquids (4 to 10 days after the accident).§ In those cases in which there is reasonable doubt that the esophagus has been damaged and there is no dysphagia, esophagoscopy should be performed without delay. This is the best procedure for determining the extent of the pathological process.[2] X-ray studies, for the purpose of determining if there is an aneurysmal dilatation of the aorta, should always precede esophagoscopy.[15]

2. Dilatations with mercury-filled rubber bougies were not started. This should be done as soon as esophagoscopy has been accomplished.‖

3. A silk thread was not swallowed. If mercury-filled rubber bougies are not available or, for any other reason, delay in dilatation is deemed advisable, the patient should swallow a thread, to be used as a guide over which to pass dilators at a later date.[16] Uhde[9] recommends that a thread be swallowed in all cases, even when mercury-filled bougies are to be used.

During the second hospitalization:

1. Dilatation was delayed, because the small Hurst mercury-filled bougies were not available.

2. The perforated lead shot attached to the thread no doubt interfered with passage of the thread through the stenosed areas of the esophagus and stomach.[17]

3. A braided thread was used instead of a twisted one, and this probably added to the difficulty.¶

4. X-ray examination, with barium swallowed prior to esophagoscopy, did not include the stomach. This examination, performed during the fourth week after the accident, showed marked esophageal stenosis and, undoubtedly, would have shown pyloric stenosis.

The histopathological examination of the fundus of the stomach was consistent with Delph's [1] statement in reference to altered digestion, and it can be assumed that in many cases in which corrosives are swallowed but pyloric obstruction does not develop there will be digestive disturbances due to inadequate amounts of hydrochloric acid and pepsin in the gastric juice.

Case 2.#—A 33-year-old white woman, on June 18, 1952, attempted suicide by swallowing a solution of Drano (sodium hydroxide). She was hospitalized for a period of two weeks, during which time she was given supportive treatment. A gastrointestinal series performed 12 days after the accident revealed an esophageal stricture (Fig. 3).

She was referred to Dr. Gordon McCoy and on July 2 was admitted to Children's Hospital, San Francisco. Esophagoscopy on July 3 revealed a strictured area in the lower third. Passage of a Jackson esophageal bougie, No. 24 F., was possible.

She was started on esophageal dilatations with Hurst mercury-filled bougies and allowed to re-

‡ Surgery performed by Col. William A. Todd Jr. and Capt. Richard P. Jobe.

§ References 2 and 9.

‖ References 2 and 9.

¶ References 9 and 16.

Case 2 is presented through the courtesy of Dr. Gordon McCoy.

turn to her home (a distance of over 200 miles), where she gradually progressed from No. 18 to 22 F. bougie by July 21, at which time she was unable to take any food.

On July 28 she was again admitted to Children's Hospital. Examination revealed marked gastric distention. A Levin tube was passed, and approximately 3,000 cc. of fluid was aspirated.

X-ray examination with barium meal on July 29 revealed marked pyloric obstruction (Fig. 4). For all practical purposes, the obstruction was complete. Only a mere trickle of barium passed through the stenosed area.

On Aug. 4, 1952, a posterior gastroenterostomy * was performed. Examination of the stomach at time of surgery revealed a hard puckered mass approximately 3 cm. in diameter in the antral region. The remainder of the stomach wall was thick, and the mucosa was flatter and whiter than normal. The entire wall lacked the usual degree of elasticity of gastric tissue.

Dilatations were resumed on Aug. 18, and by Nov. 3, 1952, the stricture had been dilated to a No. 30 F. bougie. Follow-up 18 months later revealed that she was passing Hurst mercury-filled bougies periodically and was having no difficulty.

Case 3.—A 53-year-old white man, on Dec. 11, 1953, took two swallows of hydrochloric acid, which he had mistaken for whiskey. He immediately discovered the error, and drank a solution of sodium bicarbonate and vomited.

He called a local physician, who felt that no serious damage had been done and advised him to be examined by a chest surgeon in three weeks. During this period he was unable to swallow any food other than liquids.

X-ray examination with iodized oil and esophagoscopy revealed two areas of stricture: one high in the esophagus and one in the distal third.

On admission to Letterman Army Hospital Jan. 8, 1954, he was having some difficulty with the swallowing of liquids, and had lost 30 lb. (13.5 kg.). Passage of a Levin tube, No. 12 F., was impossible.

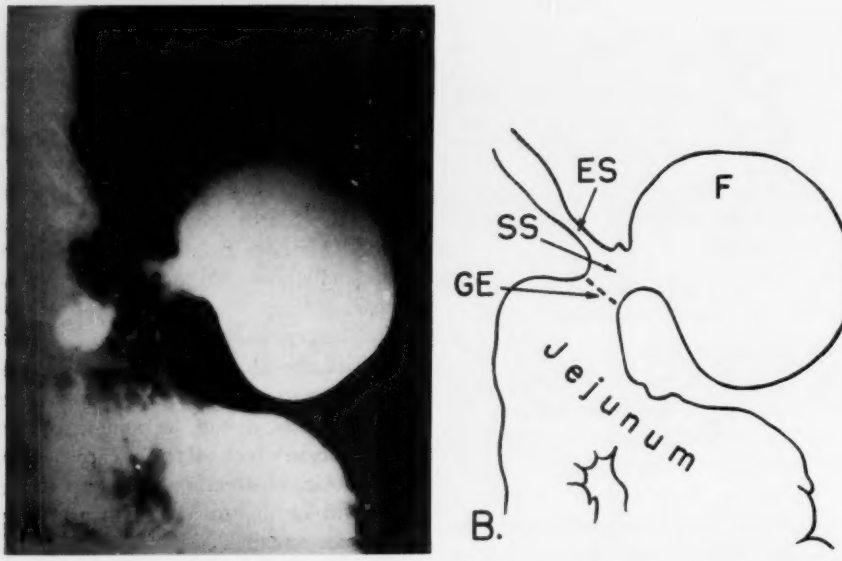


Fig. 5 (Case 3).—*A*, Roentgenogram one month after the ingestion of hydrochloric acid. *B*, Diagram of roentgenogram in *A*; *ES*, esophageal stricture; *SS*, gastric stricture; *GE*, gastroenterostomy; *F*, small remaining stomach pouch. Note: This patient had a subtotal gastrectomy and gastroenterostomy in 1943.

Past history revealed that in 1943 he had undergone a subtotal gastric resection and gastroenterostomy. After this, his symptoms of gastric distress and gastric retention were relieved, and he was in good health until the present episode.

On Jan. 9, after routine chest x-ray, esophagoscopy was performed. There was no evidence of stricture in the upper part of the esophagus. Ulceration was present in the lower third, and there was marked stricture 45 cm. from the incisor teeth. Flexible-end Chevalier Jackson bougies, No. 12 and 14 F., were passed through the stricture into the stomach. This caused slight bleeding. After the esophagoscope was removed, a No. 12. Levin tube was passed with ease.

* Surgery performed by Dr. J. W. Cline.

A gastrointestinal series on Jan. 11 revealed marked stricture of the distal end (2 to 3 cm.) of the esophagus. There was no evidence of stricture in the upper esophagus. The stomach was distorted and extremely narrow in the area between its junction with the esophagus and the site of the gastroenterostomy (Fig. 5).

On Jan. 15, 1954, at surgical conference, an operative procedure to correct the stenosis of the esophagus and stomach was planned. A delay of four to five weeks, to allow diminution of the inflammatory reaction, was recommended, providing there was no further weight loss.

He was discharged from the hospital and returned at weekly intervals for esophagoscopy and passage of Jackson esophageal dilators. He was able to take a liquid diet and lost no more weight.

On March 2, 1954, the gastroenterostomy was taken down and was found to barely admit the tip of the small finger. A curved Kelly clamp could just be passed into the esophageal stricture. A longitudinal incision, approximately 6 cm. long, was made through the left lateral margin of the strictured area of the esophagus and adjacent stomach. This incision was then closed transversely (esophagogastroplasty). After this, the index finger could be passed into the esophagus with ease. The stomach side of the previous gastroenterostomy was then closed, and a new gastroenterostomy was performed at a point more lateral on the stomach.† The small residual gastric pouch measured approximately 8 cm. in diameter and was thicker than normal. The lower end of the esophagus, the lesser curvature of the stomach, and the site of the old gastroenterostomy were markedly thickened and fibrous in texture.

After surgery there was an uneventful recovery, and, in spite of the small gastric pouch, he tolerated the usual gastrectomy regimen without difficulty.

A gastrointestinal series, on April 9, revealed some narrowing of the distal third of the esophagus, but the barium passed through without difficulty. Hurst mercury-filled bougies, up to No. 30, were passed into the stomach.

During the next week he had slight difficulty in swallowing, and on April 13 it was impossible to pass the No. 24 bougie beyond the cricopharynx. On April 20 a definite strictured area, through which the 9-mm. esophagoscope could not be passed, was observed at the cricopharynx.

Hurst mercury-filled bougies were passed twice weekly, and by May 14, a No. 40 F. bougie was passed and left in place 30 minutes. At no time during this period was there any difficulty in passing the bougies through the distal portion of the esophagus.

† Surgery performed by Dr. Carleton Mathewson Jr. and Col. William A. Todd Jr.

He will continue to pass the No. 40 bougie twice weekly and gradually increase the time interval as indicated.

CASE 4.‡—A 38-year-old white woman, on May 9, 1950, while vacationing in Southern California, attempted suicide by swallowing a glass full of a solution of lye. She had severe epigastric pain and vomited.§

She was hospitalized for a period of three weeks, during which time she was fed by stomach tube and was given intravenous fluids and other supportive therapy. Esophagoscopy was performed, but before any definitive measures could be carried out, she decided to return to her home in San Francisco.

Fig. 6 (Case 4).—Roentgenogram approximately seven weeks after the ingestion of lye. Pars media of stomach markedly constricted.

She consulted a local physician, who attempted bouginage in the office. This was unsuccessful, even with No. 16 F. bougie. Within a week she was unable to swallow. X-ray examination revealed complete obstruction to the passage of barium.

On June 16, she was admitted to Stanford University Hospital, under the care of Dr. Robert C. McNaught. Because of marked dehydration, she was given 3,000 to 4,000 cc. of intravenous fluids daily.

On June 21, esophagoscopy, with the patient under general anesthesia, revealed an acute purulent esoph-

‡ Case 4 is presented through the courtesy of Dr. Robert C. McNaught.

§ It was later reported by observers that the vomitus had eaten several holes in the rug.

agitis and a strictured area beginning 25 cm. from the incisor teeth. A Levin tube was passed into the stomach, and she was placed on multiple small liquid feedings. She could not tolerate more than 30 to 60 cc. at a time. Intravenous fluids, up to 3,000 cc. daily, were therefore necessary.

She was then transferred to the San Francisco Hospital, and, on June 20, x-ray studies of the stomach revealed constriction of the pars media (Fig. 6).

On July 15, a jejunostomy was performed, and within 10 days she was able to take all nourishment through the jejunostomy tube.

On Aug. 3, the jejunostomy was closed, and a subtotal gastrectomy and gastrojejunostomy were performed. She started swallowing liquids on the fifth day following the operation, and Aug. 12 the Levin tube was removed. The administration of intravenous fluids was no longer necessary.

On Sept. 5, esophageal dilatations were started. At first esophageal dilators were passed, under direct vision, through the esophagoscope. Later on a swallowed string was used as a guide for the passage of Plummer dilators. By Nov. 6, she had improved to the point where she could be discharged from the hospital.

She was then treated as an outpatient in the Otolaryngology Clinic, Stanford University Hospital. Dilatations were performed with Hurst mercury-filled bougies twice weekly for a period of three months, then once weekly. By Aug. 31, 1951, dilatation had progressed to a No. 34 F. bougie. She returned at weekly intervals for passage of the No. 34 bougie until Oct. 2, 1951.

She moved to another state, and there has been no follow-up.

SUMMARY

Whenever corrosive substances are swallowed, obstruction of the stomach as well as obstruction of the esophagus may occur.

Each of the four cases herein presented had stenosis of both the esophagus and stomach. It followed the ingestion of sodium hydroxide in three and the ingestion of hydrochloric acid in one.

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THE OTOLOGIST AND THE HEARING AID

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THE EVALUATION of the patient's requirements for amplification through the use of the hearing aid is one of the means of hearing rehabilitation which should be used in private otological practice. Other methods useful to the otologist in hearing rehabilitation in eligible subjects are closure of tympanic perforations, treatment of secretory otitis media with effusion, surgical correction of congenital atresia of the external auditory canal, and fenestration surgery. Since every patient should have the benefit of the optimum rehabilitation for his individual impairment, the patient needs thorough otological clearance before any one method of rehabilitation is chosen.

The hearing aid is a satisfactory means of overcoming the hearing handicap in certain persons. Over the course of several years with the hearing handicapped, one of the most noteworthy mistakes observed in hearing aid users, and those making recommendations, fittings, and sales of hearing aids, has been an ignorance of, or an unwillingness to recognize or admit, the limitations of the modern hearing aid. The problem is further aggravated by a quite general lack of appreciation of the wide individual differences present in hearing loss characteristics, and of the special problems which make hearing aid wear difficult or impossible for some patients. The crux of the whole problem is this: Not every hard of hearing person is a candidate for a hearing aid, and not every candidate can wear an aid with equal success.

The ideal candidate for hearing aid wear has an average loss of hearing of 30 db. or more in the better ear; absence of recruitment and tolerance problems for amplification; noninfected external auditory canal, middle ear, or mastoid process, and satisfactory discrimination ability, and he is psychologically prepared to adjust to the associated early noise discomfort, as well as to the supposed "stigma" of wearing an auditory prosthetic device.

WHAT IS A HEARING AID?

Hirsh [1] has described the hearing aid as follows:

> A hearing aid, strictly, does not aid hearing—it only aids, or enhances, sounds. By a process of amplification the hearing aid operates on certain physical properties of sound; specifically, it produces a sound intensity in the ear canal that is greater than the sound intensity that first impinged on its microphone. The patient's hearing or hearing loss remains the same; it must—the hearing aid was not designed to change the pathology but only to change the sound so as to compensate for the hearing loss.

Briefly, a hearing aid converts the mechanical energy of sound waves reaching the microphone into electrical energy, builds up this weak signal to a stronger signal in the vacuum tube or transistor, and then reconverts the electrical energy into mechanical energy again, by vibrations of the ear receiver, creating sound waves in the ear canal.

WHO CAN WEAR A HEARING AID?

Hirsh [1] classifies the conduction type and nerve type losses as attenuative and nonattenuative types. Attenuation is the opposite of amplification. Whenever we have a mechanical obstruction to the entrance of sound energy to the inner ear which results in attenuation (as represented in a conductive hearing impairment), the prognosis is usually good for execellent results from a hearing aid. This is because the patient needs only to have the sounds amplified or the sound level raised and he understands speech perfectly. This is usually the person who cups his hand behind his ear or leans closer and wants you to "speak up." This patient gets scores of 80 to 100% in discrimination tests administered through the earphones or speaker.

However, the outlook is not as promising for the patient with the nerve or nonattenuative type loss. This is because the nonattenuative type of patient has difficulty in understanding, or discriminating between the sounds of speech, even when they are comfortably loud. Characteristically, this patient does not want you to talk so loud, and almost invariably says, "I can hear you but I don't understand what you say." Discrimination scores on PB words of 50 to 80% usually indicate a mixed type or nerve type impairment and the outlook of some difficulty with, or only fair results from, a hearing aid. Scores of 25 to 50% indicate severe impairment of the pure nerve type and the outlook of great difficulty with, or meager results from, a hearing aid. Scores of 0 to 25% usually indicate very severe nerve type impairment and the outlook of no benefit or even poorer results with the wearing of a hearing aid than without the aid. In addition, the nerve or nonattenuative loss type patient may have other problems which make the use of a hearing aid difficult or impossible—factors of tolerance for loud sounds, and recruitment. If we limit ourselves to pure tone or speech threshold measurements in the selection of a hearing aid, we are then overlooking these elements, so vital to the evaluation of a patient's ability to wear a hearing aid, or the amount of benefit he can expect from its use. We must, then, concern ourselves with the above-threshold measurements of both pure tone and speech in order to further explore this problem.[2] Those factors to be considered are discrimination ability, presence of recruitment, and tolerance to loud sounds.

1. *Discrimination Ability.*—The patient's ability to hear the spoken word is measured by the speech reception threshold test (SRT). This measures the hearing loss for speech and is the lowest level of intensity at which he can correctly identify 50% of spondee words. Examples of these words are "baseball," "cookbook," and "jack-knife." This test is most easily administered in a quiet room through the earphones, with use of the Harvard Spondee records W-1 or W-2, available from the Central Institute for the Deaf.

The patient's ability to discriminate or understand the spoken word is measured by the discrimination loss or PB Max test. This discrimination test tells us the patient's ability to understand words at high intensity levels. The discrimination score (PB Max) is the maximum percentage of one-syllable phonetically balanced words repeated correctly at the most comfortable loudness level, which is usually 25 to 30 db. above the speech reception threshold. Examples of these PB words are "youth," "flight," "chance," and "act." In administering this test the exact decibel level of intensity need not be known in order to give a valid measure of speech understanding. In other words, this discrimination test may be made through any good record player without calibrated output levels as long as the intensity is comfortably loud through the earphones. It is most easily administered in a quiet room with Harvard PB record W-22, also available from the above-mentioned source. The discrimination score is a practical measure of the nerve function of the person tested. The two measures of speech perception taken together give us an index of the person's social adequacy (SAI) for hearing speech at low, medium, and high loudness levels. The speech reception threshold and the discrimination test may also be administered through the use of live voice by earphones or through a speaker, using the two-soundproof-rooms technique, which is the procedure normally used in our offices.

2. *Recruitment.*—Recruitment is the abnormally rapid growth of loudness in an affected ear. It is a deviation in the ratio between the psychological attribute of loudness and the physical attribute of intensity. In other words, recruitment is characterized by poorer hearing at threshold levels but more normal hearing above threshold. Suppose a patient has a threshold of 50 db. for pure tones. This compares with the threshold of zero for the normal ear. If we raise the intensity to 80 db., the nonrecruiting impaired ear will hear it as 30 db. of intensity while the recruiting ear might hear it as 80 db. or the same level as the normal ear.

The measurement of recruitment can be made by noting the placement of most comfortable loudness and uncomfortable loudness curves in relation to threshold curves for pure tones. Where convergence or a narrowed range is found, recruitment is present. This is a simple technique requiring only a standard audiometer. Its use has been compared with more elaborate and complicated tests, such as the Békésy and the difference limen method, and has been found to be superior.[3]

3. *Tolerance.*—Tolerance problems for amplified sounds are often found in the presence of recruitment. These problems are of two types:

(*a*) Presence of lowered threshold of discomfort which makes for a narrowed range within which amplification may be used.

(*b*) Inability to tolerate amplification because of peaks of adequate unaided hearing in certain frequencies.

HOW DO WE EVALUATE A PATIENT FOR HEARING AID WEAR?

The hearing aid evaluation with hearing aids or a master hearing aid affords a practical method for determining a person's ability to wear a hearing aid. It is important to reemphasize that not every hard of hearing patient can gain practical benefit from hearing aid amplification. In the hearing aid evaluation, one measurement is the hearing loss for speech and the other is the discrimination ability. These tests are first made through the speaker, using live voice or records and with the patient not wearing his aid. Then subsequent repetitions of these tests are made using comparable word lists with different aids and different settings and receivers of a particular aid, in order to establish the amount of benefit a patient can receive from any hearing aid, or the most advantageous combination of characteristics

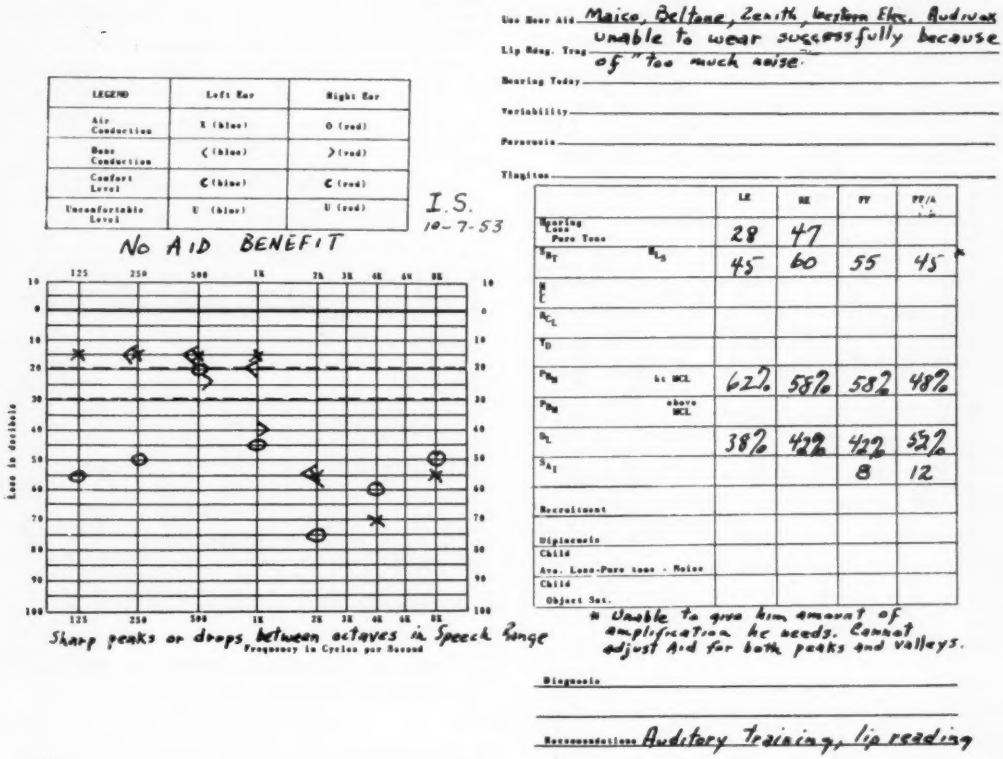

Figure 1.

which should be met in the aid to be purchased. In order to eliminate the necessity of a hearing aid library frequently used in hearing clinics, we use a master hearing aid which reproduces the chief characteristics of the major hearing aid types, including compression.[4] Also needed is a complete set of receivers and standard ear pieces to be used with the master hearing aid.

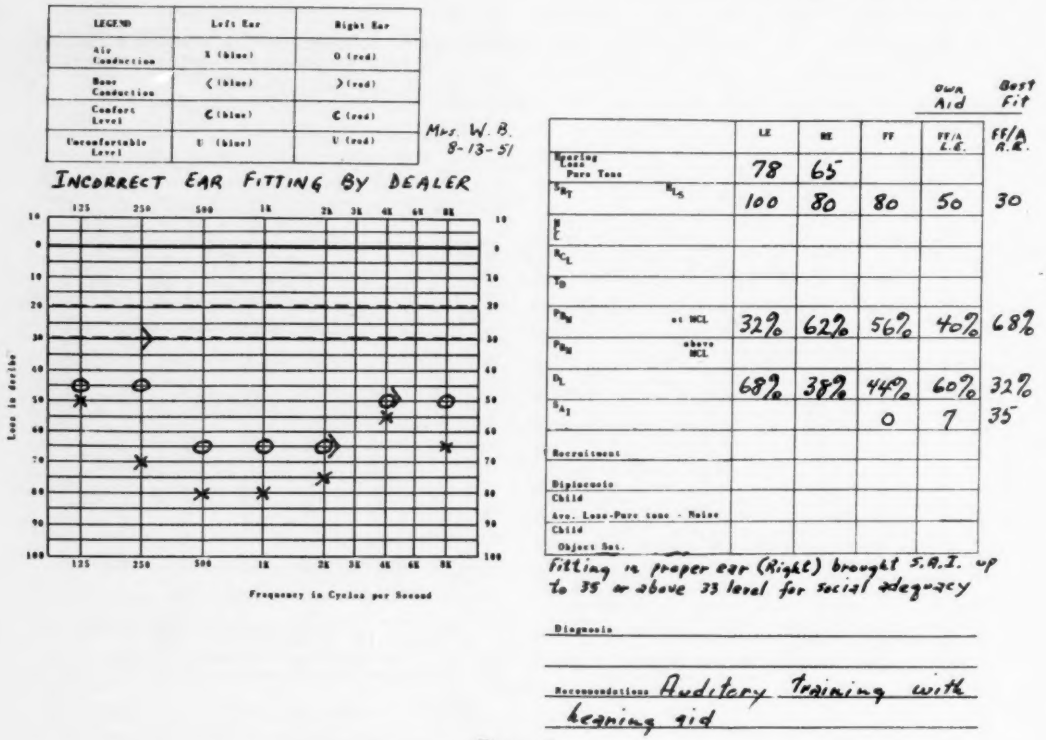

Figure 2.

efit in sensitivity, but actually understand considerably less with the aid than without it. In addition, the aid, with compression if necessary, should be tolerable to the patient at maximum volume. Figure 1 shows the case who was ruled out as a possible candidate by reason of exhibiting marked disparity between what was heard and what was not heard; specifically, a drop or rise of more than 20 db. between octaves in the speech range. This condition presents two problems —that of distortion, and tolerance of amplified sound. Distortion occurs because amplification accentuates the difference within words of sounds heard well and those not loud enough. Unusual discomfort occurs when the aid is adjusted to the threshold valleys in an attempt to bring them up to an adequate level, thereby amplifying the peaks, already heard well, to the intolerable level.*

WHAT ARE THE IMPORTANT STEPS IN HEARING AID REHABILITATION?

1. *Selection of the Candidates.*—From the hearing aid evaluation tests we determine whether the patient gets sufficient benefit from the aid to justify the inconvenience and expense involved in the use of a hearing aid. To be of practical benefit, a hearing aid should raise the sensitivity level or the ability to hear faint speech up to the practical hearing range, and should not appreciably reduce the unaided discrimination ability. Many patients with nonattenuative type (nerve type) impairments receive some ben-

* Recently several new hearing aid models have shown promise in controlling the amplification of low frequency peaks particularly.

2. *Establishing Optimum Fitting Characteristics.*—When it has been determined that an aid will give adequate benefit, it is necessary, through further evaluation, to select the correct amount of power needed, the type of receiver most beneficial, the best tone setting, and the ear to be fitted. A recommendation is then made for the purchase of an aid which meets the above qualifications from an agent in the patient's own locality who meets adequate standards for service-minded ethical practice, and who is equipped to render good repair and maintenance service. As Mueller [5] states, "No hearing aid is better than its local agent."

Figure 2 shows the importance of selecting the optimum aid characteristics giving maximum benefit. If left to their own devices, prospective buyers of hearing aids will almost invariably select the incorrect receiver type and tone setting needed for greatest hearing efficiency. They are motivated by a desire for the mellowest, most pleasant sound, or the sound most nearly like the one to which they have become accustomed, without realizing that this is very often not the fitting making for the highest intelligibility of speech. All too often the hearing aid dealer is completely unfamiliar with the frequency responses of his various receivers and tone combinations, and so he is unable to offer the necessary guidance in this matter. Other dealers are willing to accede to the customer's subjective evaluations in order to make him kindly disposed toward the purchase of their particular product. In addition, too many dealers follow an arbitrary plan of fitting the poorer ear, as evidenced by the pure tone audiogram, without regard to which ear is actually best suited, by reason of such factors as degree of speech discrimination ability. The case in Figure 2 had been fitted in the wrong ear, and when a change was made, obtained the improvement indicated.

NAME P. J. M. **Age** 57 **Race** W **Sex** M

Address _____ **Date** 10-31-53

H. A. Worn Micronic (Little benefit - seldom wears it) **When** Past year **Ear** L. E.

TYPE OF IMPAIRMENT	**LE**	**RE**	**FF**	**FF/A**	**New Aid**
Average Loss	58	40			
S.R.T.	85	50	55	20	45
Discrimination	68%	74%	52%	62%	52%
S.A.I.	2	15	8	37	13

AID CHARACTERISTICS: Power 30 volt
Setting Flat
Receiver 0 dot
Ear to be fitted Right ear

Aids Recommended Maico "L", Telex 954

COMMENTS Top position microphone because of extreme clothing noise discomfort.

FOLLOW UP Referred agent sold patient transistor (front microphone) 2 dot receiver instead of top microphone vacuum tube, 0 dot receiver. Results above. Returning with correction.

Figure 3

3. *Follow-Up Evaluation of Newly Purchased Aids by Successful Candidates.*—Figure 3 shows the importance of follow-up on all cases in which hearing aids are recommended. Because of the downward slope of the threshold curve, a no-dot receiver, with flat tone response, was recommended, to cut the low frequencies. Also, because of unusual amounts of discomfort experienced by the patient with clothing noises in his previous instrument (which he seldom wore), an aid with microphone placed at the top of the amplifier case was prescribed. A salesman from his local dealer, in his apparent over-

enthusiasm for the higher priced all-transistor aid, sold him such an instrument with a front microphone and a 2-dot receiver, emphasizing rather than cutting the low frequencies. This was done with the assurance that it "will do the same thing the other will, only better." The evidence of its much poorer performance in sensitivity and discrimination, obtained on follow-up retest, is testimony of the salesman's misplaced confidence.

4. *Adjustment Counseling and Auditory Training.*—Something must be done for the patient after the aid has been given him, in the way of guidance in adjusting to amplified sound, and in giving him access to literature and practice materials which will improve his perception and increase his communicative skill. The benefits of educational counsel, with reference to auditory training and lipreading, apply in like degree to those patients with borderline impairments, not requiring a hearing aid, and to those for whom no benefit is possible from amplification. Figure 4 illustrates the latter type of case, in which 20 hours of formal auditory training, designed to make the patient a more critical listener, improved her discrimination ability from 58% to 89%, and the social adequacy index from 30 to 69, or well above the threshold figure of 33 for adequate hearing. This social adequacy index is computed from the speech reception threshold and discrimination figures, and represents an over-all objective measure of a person's competency in perceiving speech under all conditions of listening desirability. Whenever the patient's discrimination ability is so poor that auditory training can be of no benefit, lipreading alone should be advised.

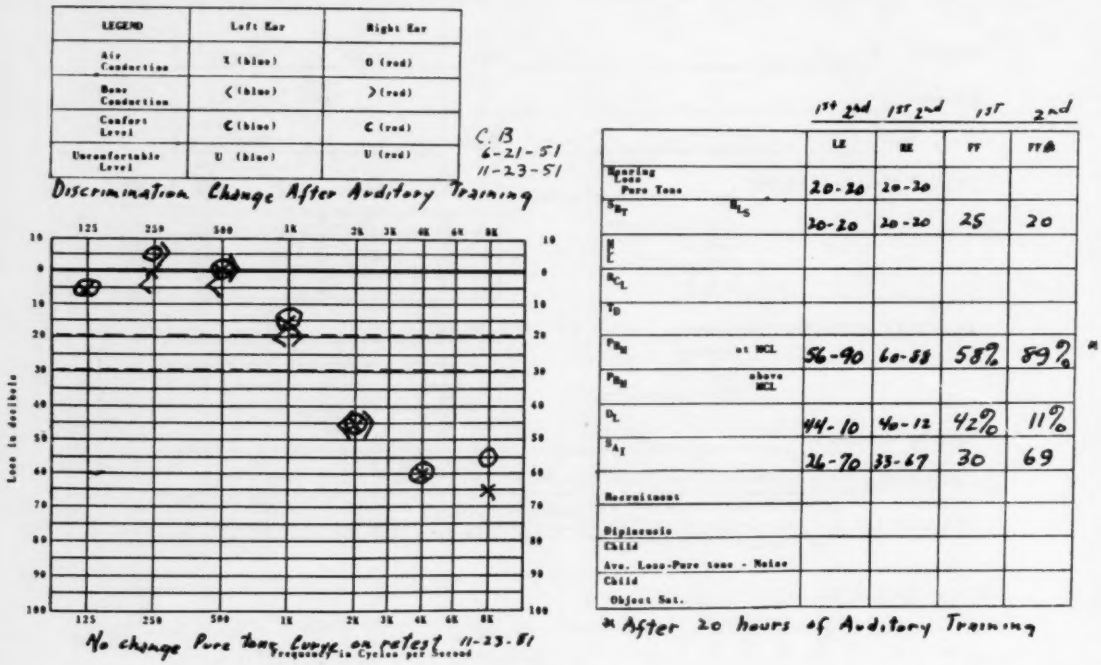

Figure 4.

WHAT IS THE COST OF HEARING AID WEAR?

In the old vacuum tube models using the carbon-type battery the length of operation of B batteries is 300 hours, and that for the A battery 30 hours. This means a cost of operation of $3.00 a month, or for part-time wear, 10 cents per day on the basis of a 10-hour-use day. In the newer vacuum tube

models using the miniature mercury type A batteries, the length of operation of the B battery is about 250 hours, with 50 hours for the A battery. Again for an average 10-hour-use day, this means a cost of from $3.50 to $4.00 a month. The original cost of these two types of aids is approximately $200. For the hearing aid using part transistor and part vacuum tube, and retaining the A and B batteries, the battery life is doubled and the cost of operation cut in half. The original cost of these instruments is from $225 to $250. In the all-transistor aid with no vacuum tubes and only a small A battery capsule, the length of life of this A battery is 300 hours and the cost of operation is reduced to 50 cents a month. Original cost of these aids is from $275 to $300. The cost of replacement of other items, such as microphones, receivers, and cords, varies with the climate, the vocation of the patient, and the care of the instrument. The average hearing aid user purchasing one of the modern type part-transistor aids will use two instruments over a five-year period, involving expenditure of $500; he will spend approximately $125 for batteries, and $150 for replacement of cords, microphones, receivers, and the like, making a total of $775 over a five-year period, or approximately $150 a year.

SUMMARY

In summary, we have discussed what a hearing aid does, who are the candidates for hearing aid use, and why some patients are less suitable than others for this hearing aid wear. In addition, we have described the tests for hearing aid candidacy, the important steps in hearing aid rehabilitation, and the costs of operation of the hearing aid. The hearing aid has great potential for the alleviation of hearing handicaps, but we feel that the otologist must take the responsibility of reducing the abuses and mistakes in its use. No group of handicapped persons is more open to exploitation by commercial interests than the hard of hearing. This is due in part to the fact that the fitting of no other prosthetic device receives as little professional supervision as does the hearing aid, and nowhere is there as little interest in establishing and maintaining standards of competency for the prothesis fitter as is found with respect to hearing aid dealers. To improve this condition, the otologist must realize the limitations of the hearing aid and prepare himself and his facilities for selecting the candidates, determining the special amplification needs of those found suitable, following up the accurate fulfillment of his recommendations, and providing the educational guidance so necessary to all those patients with hearing difficulties not amenable to medical or surgical reversal.

509 Hermann Professional Building (25).

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SUBJECTIVE CUPULOMETRY

Threshold, Adaptation, and Sensation Intensity of the Vestibular Organ for Rotations in the Horizontal Plane

G. v. BÉKÉSY, Ph.D., Cambridge, Mass.

AT FIRST glance the vestibular organ seems much simpler than the cochlea. Mechanically, the membranous ampulla, with the cupula gliding inside it, constitutes a simple system with only one degree of freedom. The shape of the deformation of this system is independent of the frequency of the stimulus. There are no traveling waves, as there are in the cochlea, that change their pattern with the frequency of the stimulating sound. The movements of the cupula have been thoroughly described by Steinhausen,[1] and the mechanical aspects of the system, consisting of the vestibular channel and the cupula, of the human labyrinth have been measured and described in a splendid series of papers by van Egmond, Groen, and Jongkees.* These papers form the basis for the development of cupulometry for clinical and research purposes. Their results have been confirmed and extended by Hallpike and Hood † in several studies carried out with a new type of revolving chair.

All the movements of the cupula are relatively slow and large; this suggests that it is a mechanically well-defined system, on which measurements can be made with great stability and reproducibility. It is reasonable, therefore, to assume that in the cupula, at least, it should be possible in time to find a technique that will separate precisely and quantitatively the mechanical changes from the neural changes during experimentation or during disease.

The main purpose of this investigation was to find out with what precision the different sensations can be reproduced in a well-defined sensory organ. This seems to be important not only for physiology and psychology but for the clinical applications of cupulometry as well.

In spite of the apparent simplicity of the cupula, however, a closer look shows up some difficult problems. Mechanically, the most interesting aspect of the cupula is the gliding surface between the inner wall of the ampulla and the outer edge of the cupula. The gelatinous surface of the cupula glides against the surface of the ampulla when the endolymph in the semicircular canal is displaced. So long as movement occurs, a thin fluid film between the two surfaces keeps friction relatively slight. But there must be a certain amount of pressure between the two surfaces to keep them tight; if the cupula stays in the same place for a longer time, the film formed by the fluid finally streams out and the friction between the two surfaces increases. This friction should reduce the sensitivity of the vestibular organ for rotation.

On the other hand, from the point of view of the nervous system, a challenging problem is raised by the fact that the five sensory organs—three ampullae, the utricle, and the saccule—are supplied with about 19,000 fibers.[11] This gives one cupula at least 3,500 fibers. It is hard to understand why such a large number of fibers is needed to transmit the simple movements of the cupula when the range from threshold to the maximal stimulus the vestibular organ can stand does not exceed the ratio 1 :100. The human auditory nerve has about 35,000 fibers, which are spread along the entire 35 mm. of the basilar membrane—that is, about 1,000 fibers

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* References 2 to 7.

† References 8 to 10.

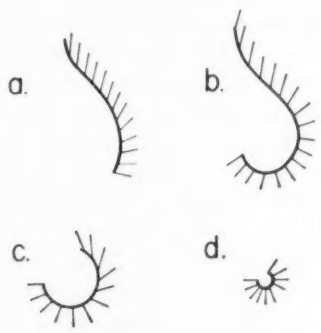


Fig. 1.—Sinusoidal rotary oscillations of the head of an observer may produce sensations of both rotation and swing, even when the axis of rotation goes through the center of the head. Four typical patterns are shown, the heavy line representing the shape of the sensed swing, and the light line the sensed position of the nose.

per millimeter. But the sound-pressure ratio between the threshold of hearing for a tone of 1000 cps and the threshold of "feeling" is about one to a million. Furthermore, the nerves of the cupula are called upon to transmit only a single sensory quality—rotation—whereas the auditory nerve must transmit several sensory dimensions, such as pitch and volume.

SWING AND ROTATION

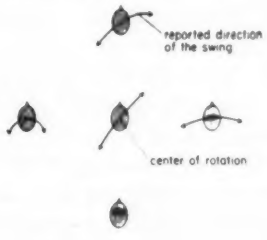
An observer seated in a chair that is rotated around a vertical axis may be aware not only of a rotation but also of a swing (an apparent horizontal displacement). Even when his head is tilted 30 degrees forward, so that the stimulus is concentrated on the horizontal vestibular canal and the head is centered so that the axis between the two vestibular organs goes through the axis of rotation of the chair, the observer feels not only the rotation but also an apparent parallel displacement of his body. The pattern of apparent displacements that the observer may experience is illustrated in Figure 1. In this experiment, the chair was rotated to the left and right in the form of a sinusoidal oscillation, with a period of one full cycle lasting 80 seconds. Even though the observer's head was centered, he reported apparent motions of the head like those shown by the heavy lines in Figure 1. In which direction the observer thought his nose was pointing at successive intervals of time is shown by the light lines.

A back-and-forth movement, such as is shown in Figure 1*a* and *b*, was commonly reported. The asymmetry of the sensation during the symmetrical rotations of the chair was striking. Sometimes the observer felt a displacement during only half the sinusoidal rotation of the chair, and a more-or-less pure rotation during rotation to the other side. After the periodic rotations had been continued for several minutes, the observer reported that the displacements of his body seemed to decrease in magnitude, leaving the sensation of pure rotation to the left and right, as illustrated in Figure 1*d*.

Figure 2 shows the form of the reported displacements of an observer's head for different positions of his head relative to the axis of rotation. One cycle of the harmonic rotation lasted 10 seconds. Many observers experienced a sensation of pure rotation when the head was placed about 30 cm. behind the axis of rotation of the chair and tilted 30 degrees forward. The curves representing the apparent displacement vary greatly. Figure 3 shows an instance of a person who sensed displacement convex to the axis of rotation when the actual physical movements were concave.

In general, both the apparent displacement and the apparent rotation of the head reach their maximal and minimal speeds at the same moments. The plane of the displacements and of the rotation seem to be hori-

Fig. 2.—When the observer's head is outside the axis of rotation, the direction and shape of the swing sensation are modified. When his head is in the central position, he may perceive a large swing, but when it is behind the axis of rotation, he may feel only pure rotation.



zontal. In only a few cases were vertical displacements reported during rotation around the vertical axis.

At the start of the experiments it was assumed that the sensation of lateral swing experienced by an observer when his head was centered on the axis of rotation might be due to some unintended tilt in the axis of the chair. This assumption was disproved by slowly rotating the center position of the harmonic motion. The pattern of the swing sensation should change if the sensation of lateral swing is due to tilting of the axis, and the pattern should remain fixed relative to the observer if it is independent of the axis tilt. When the harmonic motion was at 10 seconds and the rotation angle was 25 degrees, the form of the swing reported by the

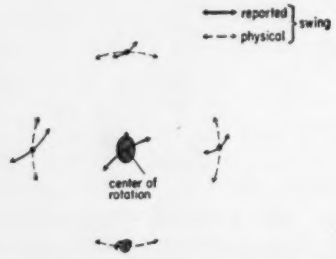


Fig. 3.—An observer sitting in a chair with sinusoidal rotary oscillation but with his head outside the axis of rotation feels, in addition to the rotation, a swing whose direction and magnitude differ decidedly from those of the physical swing. In all these experiments the observer's head was bent 30 degrees forward so that only the horizontal canal was stimulated by the oscillations. The sensation of swing probably results from stimulation of the otoliths.

observer was constant and it rotated with the head, thereby indicating that the sensed lateral swing did not result from a tilted axis of rotation in the chair.

Most of the measurements in this paper were done with the observer sitting free in the chair. But the observers were controlled in that their heads were fixed by a biting board, so that head movements relative to the chair were prevented.

The sensation of rotation is commonly ascribed to the movement of the cupula in the horizontal canal, and the sensation of parallel displacements to the functioning of the utricle and saccule. Favoring this assumption of two different mechanisms is the fact that the apparent displacements and rotations can adapt or recover independently of each other. Under continuous sinusoidal stimulation the sensation of displacement fades away faster than does the sensation of rotation. Furthermore, the threshold of apparent displacement may differ considerably from the threshold of apparent rotation.

In the following observations an effort was made to place the observer's head in such a position relative to the axis of rotation that he would report only rotation. Often this was not possible, however, and the head was then placed in the axis of rotation. But with a little training the observer was able to discriminate between rotation and swing during an observation.

ADAPTATION AND FATIGUE

Since the introduction of the cupulometer for the measurement of the sensitivity of the semicircular canals by van Egmond, Groen, and Jongkees, it has become well known that a strong rotary stimulus, such as the Bárány test, can affect the sensitivity of the cupula for several days.‡ The long duration suggests that this effect should be called fatigue. It is probably a combination of neural and mechanical after-effects.

In order to investigate the after-effects of overstimulation, the rotational speed was slowly (subliminally) increased until it reached 300 degrees per second. This speed was kept constant for about 40 seconds, by which time the observer had ceased to feel rotation. When the physical rotation stopped, the observer felt rotation in the opposite direction, and he pressed a microswitch each time he felt that he had been rotated through 90 degrees (Appendix, 2). The observer started to press the switch the moment the continuous rotation was stopped. Each time the switch was operated the recording pen moved one step upward until the observer no longer reported rotation. Figure 4*a* shows three records for one subject taken

‡ Reference 2, Figure 10.

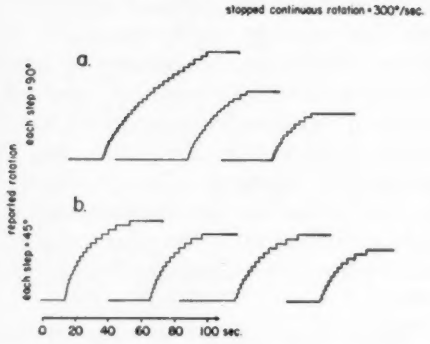
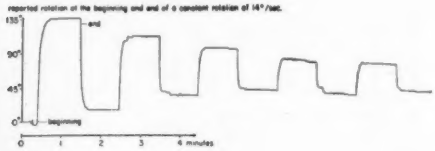


Fig. 4.—In a properly adjusted chair, an observer has no sensation of rotation during continuous rotation, but when the chair is stopped, he instantly feels rotation in the opposite direction. The observer was asked to press a switch whenever he felt that he had rotated through 90 degrees (*a*). Each depression of the switch moved the pen a notch upward on the roll of moving paper. Repeated stimulations produce smaller and smaller sensations. (*b*) A similar curve for an insensitive observer who reported whenever he felt that he had rotated through 45 degrees. The smaller angle was necessary because of his lesser sensitivity.

at about four-minute intervals. Prior to the first test the subject had not been rotated for three days. Figure 4*b* shows similar curves for an insensitive subject who reported every 45 degrees. The total size of the rotation reported with successive tests decreased more rapidly for sensitive than for insensitive observers.

But even for physiological stimulations the decay of the sensed rotation may be appreciable. The record in Figure 5 shows the rotations reported by a subject at the starting and stopping of a continuous physical rotation of 14 degrees per second. For one-minute periods the chair was geared to a constant speed. The subject, whose eyes were closed, was asked to keep his hand outstretched and always to point to the same point in the room (Appendix, 2). When the speed of the chair was suddenly changed, he felt a rotation, for which he compensated by moving his hand in the opposite direction. The relation of these hand movements to the movements of the chair was recorded for one observer in Figure 5. The hand movements stop after a short time, because there is no sensation of rotation when the speed is constant.

Fig. 5.—The revolving chair was rotated with a constant angular velocity for one minute and then stopped. Each time the movements were accelerated or decelerated a sudden sensation of rotation occurred. The ordinate represents the angle of sensed rotation. It decreases constantly with repetition of the acceleration and deceleration.



Even for accelerations near the threshold, a continuous decay of the magnitude of the sensation is reported with successive stimuli.

THRESHOLD MEASUREMENT AND THE DIFFERENCE LIMEN

Before the threshold measurements were begun, measurements were made of spontaneous rotations in the horizontal plane, reported by an observer in the absence of a physical stimulus. The observer, seated in an immobile chair in a completely dark room, was asked to keep his hand outstretched, as fixed as possible relative to the room, and to compensate any feeling of rotation by a movement of the hand in the opposite direction. Figure 6 gives the records of three observers. It was not uncommon for the observers to indicate sudden rotation of three or four degrees.

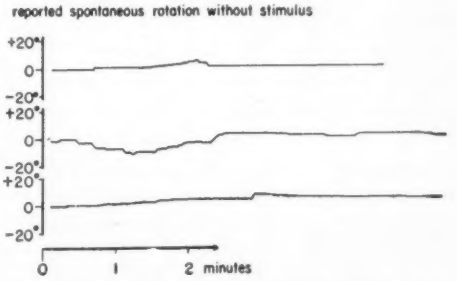


Fig. 6.—While sitting motionless in a fixed chair, most observers report small spontaneous rotations to the left and right. The curves show the records of three observers.

Observations of temporal changes near threshold can be made most conveniently with continuous sinusoidal rotary oscillations. In each period the same phenomena

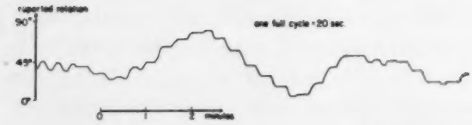


Fig. 7.—Near the threshold, rotary oscillations of the chair to the left and to the right are sometimes not equally well perceived. In this event, the observer feels that the chair is moving in only one direction in successive steps.

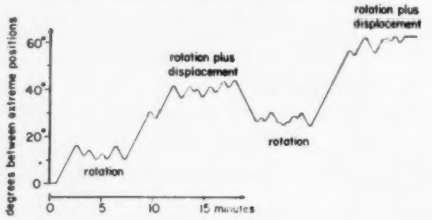
can be observed, and many repetitions recorded with a short time interval bring out data that can hardly be obtained otherwise. When the amplitude of the oscillations is kept constant near threshold, the sensed oscillations do not always remain symmetrical. The observer notices rotation in one direction only and receives the impression that he is being rotated in the same direction in successive steps. This sensation usually lasts only a minute or two, after which the oscillations may again become symmetrical, or the direction of the sensed stepwise rotation may seem to reverse. Figure 7 shows such a record for oscillations of 20 degrees. A probable explanation of this phenomenon is that the stimulus falls below the threshold of sensation for one direction of acceleration before it falls below the threshold for the other. When the vestibular threshold is compared with the auditory threshold, it is noted that a pure tone can often be definitely perceived, although a higher sound pressure would be necessary for its pitch to be determined. Analogously, in the perception of motion, the question is whether, with increasing amplitude, the sensations of rotation and direction of rotation might appear simultaneously. About half the observers stated that the two sensations were simultaneous; the other half needed an increase in amplitude in order to determine the direction. It may be that the feeling of rotation without the ability to determine its direction is the first sign of an abnormality of the vestibular organ.

The apparatus to measure the threshold of rotary oscillations of the horizonal canal was similar in principle to the recording audiometer described elsewhere.[12] When the observer pressed a switch, the amplitude of the oscillations was increased continuously and automatically until threshold was reached; the subject then released the switch, and the amplitude decreased automatically. When all sensations had disappeared, the observer again pressed the switch, and the process was repeated. The magnitude of the oscillations was recorded automatically and instantaneously as the subject made the amplitude wobble around his threshold (Appendix, 2).

When the amplitude is increased from subliminal values, the observer first feels a pure rotation; only upon further increase of amplitude does he feel a sensation of displacement as well as rotation. Figure 8 presents records made by a subject who alternately observed the threshold for pure rotation and the threshold for displacement. The period of the oscillations was 10 seconds. The ordinate represents the angle between the maximum excursions of oscillations. The records shown in Figure 8 are for a particular insensitive observer. Other observers, with their heads in the same central position, recorded the threshold for displacement two to three and one-half times higher than the threshold for pure rotation.

In Figure 9, a continuous record of the threshold for pure rotation shows that the amplitude of the oscillations must be continuously increased with time in order for the sensation to wobble around threshold. Very few observers showed a constant threshold for a long period of time, like the one shown in Figure 9*b*. The threshold for pure rotation of some observers rises with unexpected rapidity, especially in the morn-

Fig. 8.—Two thresholds for the rotary oscillations of the chair can be measured: (1) a lower threshold for the first sensation of pure rotation and (2) a higher threshold for a sensation of swing.



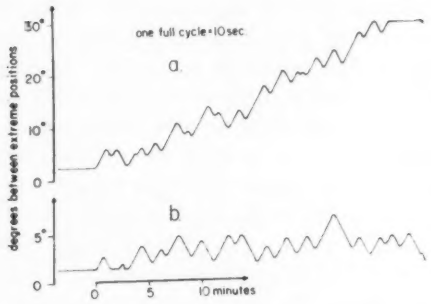
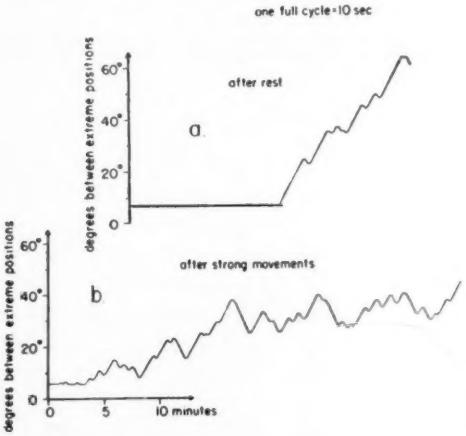


Fig. 9.—Threshold curves for rotary oscillations with a period of 10 seconds. The threshold was measured by a device that automatically increased the amplitude of the oscillations until they were perceived, then decreased them until they vanished. The rise and fall of the curve represent the fluctuation around threshold. The observers' thresholds usually increased continuously during the measurements, as in curve *a*. Curve *b* shows a less common pattern, in which the threshold was more constant.

ing (Fig. 10*a*). After a few minutes of vigorous exercise, the observer's threshold may ascend and become much more stable (Fig. 10*b*). Control tests showed that sitting still for 20 minutes in an unmoving chair does not result in a rise in the threshold: it is not immobility, but oscillations of the chair, that raise the threshold. This is especially true of sinusoidal rotary oscillations, the kind that make babies sleepy. Strong, irregular movements on the part of the observer may have the opposite effect on the threshold.

Fig. 10.—The threshold for oscillation in a chair may be high in the early morning, and may go down after a few minutes of vigorous exercise.



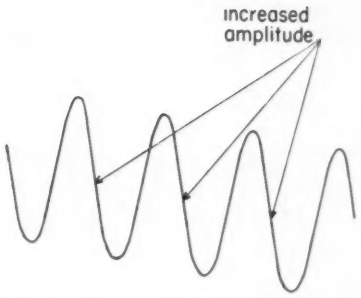
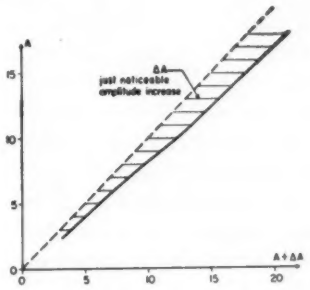


Fig. 11.—In order to measure the difference limen for the amplitude of the oscillations in each cycle, the observer increased the amplitude of rotation to one side until he could feel that one side of the rotation was larger than the other.

In the apparatus used to record the threshold, the pen fluctuates between the amplitudes of the rotary oscillations that are just perceptible and those that can no longer be perceived. The fluctuations represent to some degree the difference limen for the rotary oscillations near threshold. In Figures 9 and 10 it is evident that the fluctuations are of the order of one to three degrees in size, and they seem to be fairly independent of the actual size of the rotary oscillations.

The following method was used to measure the difference limen above the threshold. During half the rotary oscillation of the chair, the amplitude of the oscillation could be increased or decreased by the observer. In order to avoid any jerking, the motor was set to make this change when the chair had reached the turning point. The chair now rotated more slowly to one side than to the

Fig. 12.—The values ΔA indicate how much the amplitude of one side had to be increased relative to that of the other side for the observer to notice the difference. ΔA increases with the amplitude A of the oscillation.



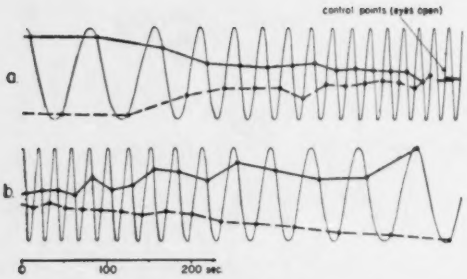


Fig. 13.—During sinusoidal rotary oscillations of the chair, the observer pressed a key whenever he felt no motion These responses appear as dots along the sinusoidal curves that represent the physical stimulus. The solid line connects the sensed turning points on one side, the dotted line on the other side. When the length of the oscillations is changed, there occurs a phase shift between the physical stimulus and the sensation.

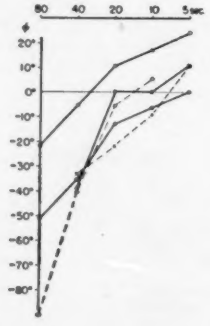
other, as Figure 11 shows. The observer was asked to increase the difference between the amplitudes until he could detect the difference in size between the left and right rotations. These amplitude differences are shown in Figure 12. In order to eliminate the effects of a possible asymmetry between the observer's ears, the increasing of the amplitude was alternated from side to side. The just noticeable differences (ΔA) in the amplitude of the oscillations seem to increase as the amplitude increases.

THE PHASE ANGLE BETWEEN STIMULUS AND SENSATION FOR SINUSOIDAL ROTARY OSCILLATIONS

If, during continuous stimulation with a sinusoidal rotary oscillation, an observer feels no movement at the moment when the cupulas are going through their position of normal equilibrium, then it should be possible to measure many physical properties of the vestibular canal by means of the phase angle between the stimulus and the sensation. Van Egmond, Groen, and Jongkees[2] were the first to determine the resonant frequency of the cupula by this means. We repeated their measurements with an automatic recording device and corroborated their observations. With the equipment described in the Appendix, 2, it was possible to record the momentary angular velocity of the chair. In Figure 13 the velocity is represented by the sinusoidal line, the high point of the curve representing the maximal velocity to the right, and the low point to the left. The observer kept his microswitch depressed so long as he felt no movement. This was recorded on the sinusoidal line by the pen's being moved a little out of its normal position. The points on the sinusoidal curve in Figure 13 indicate the midpoint of the time during which no sensation was felt. The solid line connects the points of sensed motionlessness on one side, the broken line on the other side. During a continuous increase or decrease of the length of one cycle of the oscillation, the phase between stimulus and sensation shifts about 90 degrees. As a control, the observer was asked to record the turning points of the oscillations while his eyes were open (right-hand side of Fig. 13*a*). The observations were relatively easy to make so long as one cycle of the oscillation was longer than five seconds and the acceleration was kept approximately constant. However, if, during the changes of the oscillation period, the amplitude rather than the acceleration is kept constant, the sensation is too weak over long periods to permit a precise indication of the turning point of the oscillation.

The phase shift that accompanied a change in the length of the cycle was quite different for different observers, as can be seen in Figure 14. The resonant frequency, defined by $\phi = 0$, of the cupula varies in the two extreme records from 5 to 30 seconds. Dissections show that the mass of the oscillating

Fig. 14.—Phase shift between stimulus and sensation for different frequencies. Records of five observers.



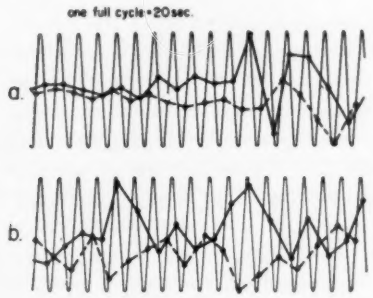


Fig. 15.—For a given continuous rotary oscillation of constant frequency and amplitude, sudden changes in the position of the sensed turning points of the oscillation (relative to the stimulus) may occur. Two different patterns of sudden changes may be distinguished.

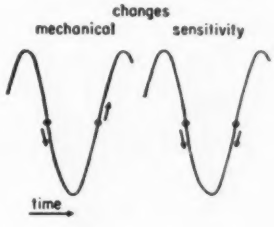
fluid in the vestibular canal systems is practically the same in different people. If the damping of the oscillations were small, we would have to conclude that the elastic properties of the cupula differed greatly in different people, to account for the differing resonant frequencies. In so highly damped a resonant system, however, the changes in the resonant frequencies are probably caused by a change in the friction. In order to determine the reliability of these observations, we made continuous records of the sensed turning points of the oscillations.

The experimenters watched the turning points of the oscillations for several hours to see whether sudden shifts in phase occurred. A 20-second cycle was found to be the most convenient frequency of oscillation to observe. Sudden phase shifts occurred repeatedly; shifts up to 60 degrees are fairly common. Usually the phase shifts follow no regular pattern. Sometimes several minutes pass with almost no change, followed by sudden, irregular changes (Fig. 15*a*). In the pattern of the phase shift, two types of irregularity can be discriminated, which sometimes last for from 3 to 10 minutes. In one type, shown on the right-hand side of Figure 15*a*, the sensed turning points of the oscillations of both sides shift together simultaneously (up or down in the figure). In the other type, illustrated in Figure 15*b*, the points of either side shift in the opposite direction (crossed lines in the figure). In some observers the patterns are so clearly distinguishable from one another that I do not think that they may be dismissed as a statistical accident.

If there is a change in the friction in the vestibular system (let us assume, at the same time in both ears), then the phase between the stimulus and the movements of the cupula will change, and either a time delay or a simultaneous leap forward will result at the turning points of the oscillation to either side. As can be seen in Figure 16 (at the left), this mechanical phase shift moves one point up and the other point down along the sinusoidal line. A mechanical change in the vestibular organ would produce the pattern of shifts shown in Figure 15*b*. On the other hand, if the cupulas become more sensitive to rotations to one side and approach the point of producing a spontaneous rotation to that side, then both turning points will move simultaneously to one side and will come closer together during the oscillation. This is illustrated in the right-hand curve of Figure 16. Such a change in one direction of rotation may occur as a result of asymmetric sensitivity of the cupulas for deflections in the two directions. It may be purely neural in origin, or it may be produced by a long-lasting mechanical deflection of the cupulas to one side.

In this connection Figure 17 is of interest. One observer complained of sudden and continuous sensations of rotation to one side which occurred without any stimulus. In order to determine whether the origin was mechanical, we measured the resonant fre-

Fig. 16.—A mechanical change in the properties of the cupula and a change in the sensitivity of the vestibular organ may produce different displacements of the turning points relative to the movement of the chair.



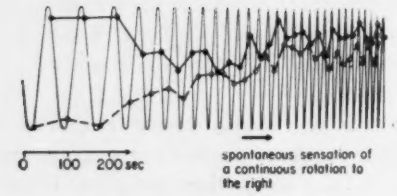
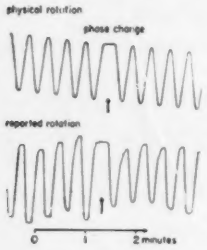


Fig. 17.—Phase shift during a spontaneous feeling of continuous rotation to one side.

quency. As can be seen in Figure 17, the solid line and the dotted line come together during the frequency change and do not change their distance from each other when the sudden feeling of continuous rotation to one side begins. I believe, therefore, that there was no mechanical change, since the resonant frequency did not change, but that the simultaneous rise of the two curves results from neural action.

It is often difficult to distinguish what is of neural origin from what is produced by the mechanical properties of the cupula. For instance, during a continuous rotary oscillation, when the phase of the oscillations is suddenly reversed 180 degrees (upper drawing, Fig. 18), the reported movements (lower drawing, Fig. 18) effectively reproduce the actual movements during the phase reversal. (This curve was obtained by the method in which the observer kept his finger tip fixed in relation to the room during the rotation.) The precise agreement between the physical stimulus and the sensation speaks for high damping of the cupula. On the other hand, if the continuous rotations suddenly stop after 10 or 15 minutes, the sensation of oscillation sometimes does not stop immediately,

Fig. 18.—The damping of the movements of the cupula is very high. This is shown by the fact that a sudden phase reversal of the rotary oscillations of the chair is followed precisely by the sensation.



as would be expected from the results obtained with phase reversal. Figure 19 shows that the sensation of oscillation may persist for one or two cycles or even longer, as has also been reported by Travis and Dodge.[13] I found that for oscillations of large amplitude this decay effect is very small but that near threshold a certain rhythm is established, which may persist. This rhythm facilitates the observations and is probably of neural origin.

THE RELATION BETWEEN STIMULUS AND SENSATION FOR DIFFERENT INTENSITIES

After a short period of training most observers are able to report sensations of rotation in degrees. A particularly simple method of reporting is for the observer to point toward some part of the room during rotary oscillations. When his eyes are open he can do this accurately, and a record of the movements of his finger tips relative to the oscillating chair give a measure of the oscillations of the chair. Such a record is seen on the left-hand side of Figure 20. If the room is then darkened and the oscillations continue at the same amplitude, the observer will still compensate each sensed rotation of his body by a rotation of his hand relative to the chair. The right side of Figure 20 shows that this sensed rotation is generally smaller than the actual rotation of the chair.

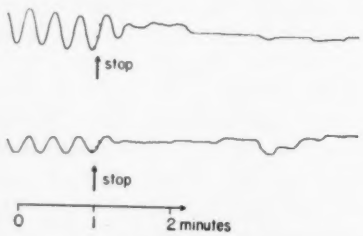


Fig. 19.—If continuous rotary oscillations are suddenly stopped after 10 or 15 minutes, the sensation of oscillation does not stop immediately. This is particularly pronounced near threshold.

In Figure 21 the abscissa represents the actual oscillations of the chair (degrees between the two turning points of oscillations) and the ordinate, the compensatory move-

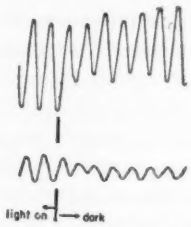
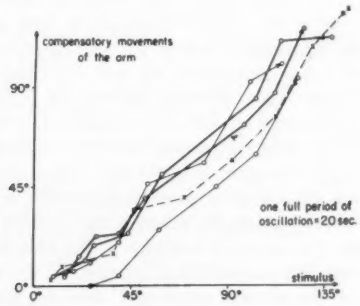


Fig. 20.—In order to obtain a quantitative report of the size of the perceived amplitude of the oscillations, the observer kept his hand fixed relative to the room. The hand movements were recorded in both a light and a dark room. The left side of the figure represents the size of the stimulus and the right side the sensed rotations.

ments of the observer's arm relative to the chair. The magnitude of the stimulus varied from 1 to 10, and in this range the records of the five observers hardly deviate from a straight line. Unfortunately, it is not possible to work with large oscillations, because the effects of inertia on the hand and on other parts of the body become perceptible.

A larger range of the stimulus can be used, however, when the chair is accelerated slowly to a certain velocity of rotation which is kept constant for a while, and is then suddenly stopped. The stimulus can be measured by the constant angular velocity before the stop. If the acceleration at the beginning was sufficiently slow, there is no sensation of rotation until rotation stops, but the moment it stops the observer feels himself rotating. Again, this sensation can be reported by a compensating rotation of the hand. In Figure 22 the rotations reported by one observer are shown for different angular velocities. In

Fig. 21.—With a stimulus whose range is in the ratio 1 : 10, the magnitude of the sensation increases linearly.



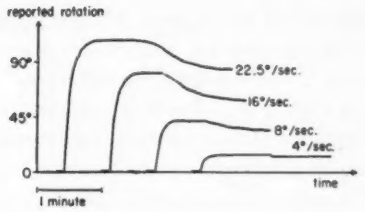
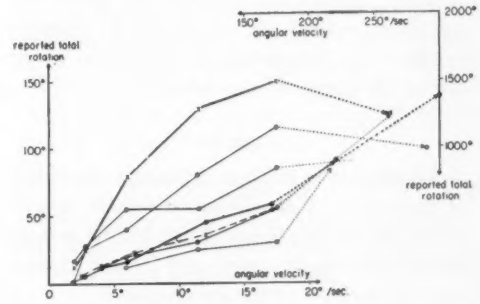


Fig. 22.—The chair was accelerated slowly, then kept at a constant speed, and then suddenly stopped. The moment the chair stopped, a rotation was felt and recorded by means of hand movements. The sensed rotation consisted of two phases—first an increase of angle, then a decrease.

all the curves the reported rotations consist of two phases: first, rotation in the opposite direction to the actual rotation, and second, a much smaller rotation in the direction of the actual rotation. This sensation is well recognized for stronger stimuli, particularly in the investigations of M. H. Fischer.[14] In the present experiment, we took the maximal reported angle as a measure of the sensation level.

Figure 23 shows results for seven observers. The abscissa represents the angular velocity of the halted continuous rotation, and the left-hand ordinate, the maximum reported angle of rotation. Angles of rotation larger than 150 degrees cannot be reported by rotation of the arm. These larger stimuli were recorded, therefore, by the continuous recording method described in the Appendix, 2: the observer pressed a microswitch whenever he felt himself rotated

Fig. 23.—In a stimulus range of 1 : 100, the magnitude of the sensation increases linearly for some observers. But for others the increase of the sensation is first rapid and then slow. The rate of increase of sensation with the stimulus varies from person to person.



through 45 or 90 degrees. All the responses were added together, and the total rotation reported is presented on the right-hand ordinate of Figure 23. The corresponding angular velocities of the chair are indicated at the top of the drawing.

If stimuli of the order of 200 degrees per second are applied more than once, the magnitude of the sensation drops considerably, as was shown in Figure 4, and a very small increase in the sensation is obtained. In order to eliminate the effects of adaptation and fatigue, measurements were carried out as follows: first, a few measurements were made near threshold in order to determine the slope of the curve; then a single observation was made with an angular velocity of above 200 degrees per second. No measurements were taken for the next four days. The measurements were then repeated. In Figure 23 the observations with small stimuli are connected to the observations with the large stimuli by dotted lines. The coordinates on the drawing are so placed that, if the relation between stimulus and sensation is linear, the slope of the dotted lines at the right of the figure should be the same as the slope of the lines at the left of the figure.

It can be seen from Figure 23 that there are observers for whom the sensation increases linearly with the stimulus; the curves were consistent over several months. Other observers, however, record a steep slope for small stimuli and a flat slope for larger stimuli. The maximal total amount of rotation that is reported seems to be approximately the same for different observers, but the speed with which they reach it varies from person to person. Roughly speaking, it may be that in some persons all the available nerve elements are excited for small stimuli, whereas in others the excitation is distributed along the whole range of the stimulus.

SUMMARY

An attempt is made to determine the range of fluctuation of vestibular sensations in normal persons; this is important for the proper design of a cupulometer, and for the evaluation of measurements for diagnosis.

The variation of the threshold with time was recorded by means of a semiautomatic device. The effects of repeated stimulations, weak and strong, were tested for five observers, and the relation between stimulus and sensation for rotations in the horizontal plane was investigated. The measurements of the resonant frequency of the cupula seem to make it possible to determine when a mechanical change of the vestibular organ is involved and when only the nervous system is involved. Thereby mechanical and neural changes may be discriminated. The Appendix describes the mechanical revolving chair and the means used for reporting sensation.

APPENDIX

1. Revolving Chair

A good design for a revolving chair presents difficult problems. To overcome the inertia of the chair and of the observer, relatively large forces are needed, and yet the smallest irregularities must be avoided, since they can be perceived as vibrations and may give cues to the observer. For standard clinical use, an electrically driven chair as developed by Hallpike, Hood, and Byford [8] seems to be a good solution. Since I was especially interested in very slow oscillations, I felt that mechanical control would prove practical. The mechanical drive has the disadvantage of noisy couplings, but it has the advantage that recorders and limiting switches can be conveniently attached to the moving parts.

The mechanically driven chair is shown schematically in Figure 24. On the left-hand side a synchronous motor (M_1) which rotates at a constant speed is attached to a coupling (C_1) with continuously adjustable speed. The speed of C_1 can be varied by means of the handle H_1. When the chair is set in oscillation, the position of the handle H_1 determines the amplitude of the oscillations. The small motor m_1 allows the observer to adjust the position of the handle H_1. When threshold measurements are being made, this motor increases the amplitude of the chair oscillations so long as the observer depresses a switch, and decreases the amplitudes when he releases the switch. The handle H_1 is connected to a pen which records the amplitudes of the oscillations. This is similar in principle to the recording audiometer described elsewhere.[12]

A second constant motor (M_2) with a variable coupling (C_2) rotates an eccentric wheel, or cam. This wheel periodically reserves the coupling in C, so that the constant rotation of the coupling C_1 goes over into an oscillating rotation. In the middle position, the variable coupling C does not transmit

any movement to the axis A. It changes the speed sinusoidally with the position of the eccentric wheel in both directions. The rotations of the axis A are transmitted by means of a steel cord to the revolving chair, which is situated in the other room. The variable coupling C_2 adjusts the frequency of the oscillations, and the small motor m_2 makes possible a continuous change in the frequency during the measurement of the resonant frequency of the cupula.

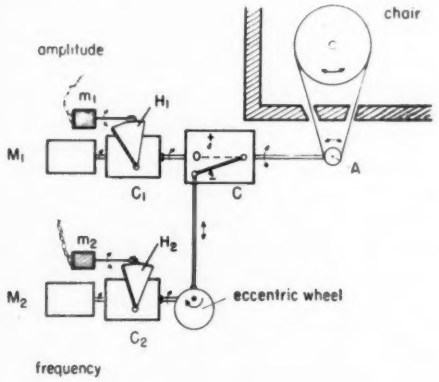
If the motor M_2 is stopped while the coupling of C is in an extreme position, a continuous rotation of the chair results. Detachment of the chair from this rotation is accomplished by a special coupling.

2. Techniques for Reporting the Magnitude of the Sensed Rotation

Measurement of the sensation of rotation is possible because an observer can state the moment when he thinks that he has made a complete turn or a fraction of a turn.§ Our observer pressed a microswitch every time he believed that he faced one of the four walls of an imaginary immobile room. Each movement of the switch agitated a stepping relay (of the kind used in automatic telephone switchboards), which in turn rotated an axis forward a certain degree. Those movements were transmitted to a pen, which recorded on a roll of moving paper a curve showing the decline of the sensed speed of rotation with time, and the total perceived rotation.

§ Reference 7, Figure 4, p. 23.

Fig. 24.—A mechanical revolving chair that produces sinusoidal rotary oscillations and transients. Coupling device C with continuously adjustable speed permits changing and reversing the angular velocity of shaft A, to which the chair is attached. An eccentric wheel may move the handle of the coupling C so that a sinusoidal rotary oscillation is produced. The frequency of these oscillations can be changed by the coupling C_2, and the amplitude by the coupling C_1. Both adjustments can be made by the observer.



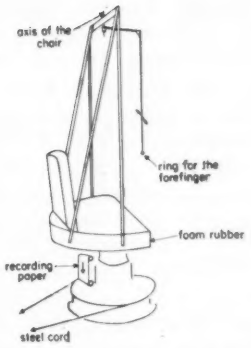


Fig. 25.—Revolving chair with a lever arrangement to record the movements of the forefinger on a recording paper mounted on the back of the chair. The arm with the ring for the forefinger was coupled with the pen on the recorder by means of a thread not shown in the figure.

Angles smaller than 45 degrees were difficult to report; therefore, hand movements were recorded in a manner similar to the technique described by Travis and Dodge.[13] The observer placed his forefinger in a ring that hung before him. He then kept his hand fixed relative to the room during the movements of the chair. The ring was attached to a lever that rotated through the axis of the chair (Fig. 25). The angular displacements of the lever were transmitted to a recorder on the back of the chair which rotated with the chair. The observer was trained first in a lighted room, while the chair rotated at small angles to the left and right. When the room was darkened, the observer had two means of compensating for the rotations of the chair with his hand: in one he imagined a fixed room and kept his hand fixed relative to the imagined room. We used this type of observation for fast and small rotations. When the rotation speed is very small, however, an easier method of reporting is to move the hand with the speed of the perceived rotation, but in the opposite direction. In this second method, the observed speed is instantly compensated for by the hand movement—without reference to any imagined room. For longer-lasting rotations this was the better method, although the imagined-room method gave the same results after short training. For very quick movements only the imagined-room method can be used, since the observer has no time to observe speed, whereas it is easy for him to tell the total angle of rotation.

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ACUTE OBSTRUCTION OF THE UPPER RESPIRATORY TRACT

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INTRODUCTION

FROM TIME to time the causes and treatment of acute obstruction of the upper respiratory tract need to be brought to the attention of the medical profession. The number of these cases in relation to the total number of admissions to a 560-bed general hospital is not large, but the urgency of prompt correct therapy in order to save lives gives them an importance beyond their numbers. Their urgent nature makes it imperative that all practitioners, as well as many of the specialists, know how to manage these problems. The care of these patients during the first few hours of the acute obstructive episode is important. We have thought it helpful to review the cases entering Episocopal Hospital during a five-year period. In this paper we shall present representative cases of the various types of obstruction which have been encountered and review the manner in which they were managed.

The five-year period from Jan. 1, 1949, to Jan. 1, 1954, was studied. Nineteen emergency tracheotomies were done in this period out of a total of 40 tracheotomies, making 47.5% of those done of an emergency nature. There were 50,303 hospital admissions during the five years studied, and thus there was one emergency tracheotomy done for every 2,647 admissions.

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GENERAL INFORMATION ON THE TRACHEOTOMY AND ITS CARE

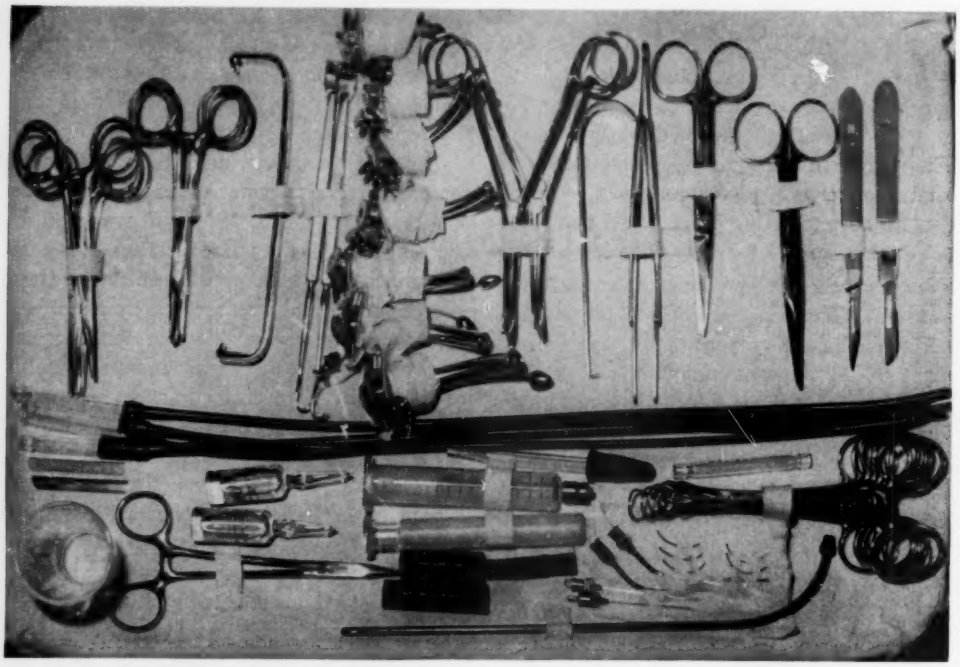
Since the majority of these cases are first seen in the receiving ward of the hospital, it is important that the physician in charge recognize a case of upper respiratory obstruction and that he be prepared to do an emergency tracheotomy if time does not permit the arrival of the responsible resident or staff physician. The indrawing of the supraclavicular spaces, the labored inspiration, the stridor, the cyanosis, the rapid weak pulse, the fatigue, and the anxious facies of a case of obstruction of the upper respiratory tract should be instantly recognized by all physicians. When these signs are present, tracheotomy, or passage of a bronchoscope or endotracheal tube followed by tracheotomy, must immediately be done to establish an airway. To avoid delay and confusion one service in the hospital should be responsible for and should supervise all tracheotomies. This is important from the point of view of the operation and postoperative care. In our hospital the Broncho-Esophagology Service has assumed this responsibility.

All receiving wards should have available for immediate use a sterile tracheotomy tray (Figure). This tray should be clearly marked and should contain all necessary items for a tracheotomy. In such emergencies a scalpel blade or a scissors dulled by repeated steam sterilizations is much to be preferred to even minimal delay in obtaining cutting instruments from another tray or solution. Besides the tracheotomy tray there must be available, ready for use, a tank of oxygen with a gauge for the administration of oxygen by catheter. There must be an aspirating machine with a long cord that can reach the side of any of the receiving ward beds.

The technique of tracheotomy has been well described by Jackson and Jackson [1] and by others,[2] so it will not be repeated here.

We shall reemphasize that in many cases it is easier to pass a bronchoscope or endotracheal tube to relieve the obstruction and then do an orderly tracheotomy. The tracheotomy is thus much easier, since the accessory muscles of respiration are not being used and the patient is quiet. In fact, in many cases the patient will sleep during the tracheotomy because of exhaustion from the previous struggle for air. Cutting down on the bronchoscope protects the tracheoesophageal "party-wall" and prevents the gasp and forward lunge which at times accompany opening the trachea in late cases, and which contribute to injury to the "party-wall." One should not use this method unless he is experienced in passing a bronchoscope. The operator should use the method which is most rapid and with which he is most adept.

Another possible occurrence to be watched for at the time of the insertion of the tracheotomy tube or bronchoscope is a period of prolonged apnea. This is due to the fall of the carbon dioxide level in the blood stream following the first respirations after the relief of obstruction.[3] The respiratory center no longer has the stimulating effect of carbon dioxide to which it has become accustomed,



Tracheotomy Tray Containing All Necessary Items Ready for Use

3 No. 3 Knife handles
1 with No. 10 blade
1 with No. 11 blade
1 with No. 15 blade
1 pair Mayo scissors
1 pair Suture scissors
1 Thumb forceps
1 Tissue forceps
1 Tracheal hook
1 Adult Trousseau dilator
1 Child Trousseau dilator
Tracheotomy tubes with tapes
1 No. 0 1 No. 4
1 No. 1 1 No. 5
1 No. 2 1 No. 6
1 No. 3
1 pair Senn retractors
1 pair Brewster retractors
6 Straight Crile tracheal tubes
2 Straight mosquito hemostats
2 Allis forceps
4 Rubber catheters
Sizes 8, 10, 12, and 14, with glass connectors
2 Ampule files
1 Medicine glass
1 Needle holder
2 Ampules 1% procaine
1 Medicine dropper
1 10 cc. syringe
No. 32 Wire suture
No. 35 Wire suture
3-0 Black silk suture
1 Glass connecting tube
6 Towel clips
Needles
5 Cutting edge ½ circle suture needles
2 Tracheal needles
2 No. 20 gauge 2 in. needles
1 Laryngeal aspirator
To be added but not shown on photograph:
2 Gowns
2 pairs Gloves
6 Towels
1 Drape sheet
Gauze sponges
6 Painters
Prep. basin with 3 cups

and, since it is fatigued, respirations cease. Anoxia then appears but fails to activate the center because anoxia is less of a stimulating factor than an elevated blood carbon dioxide level. This phenomenon is more serious in the older patients and is usually seen where the obstruction has been long-standing. In our experience it has appeared mostly in cases of obstruction due to carcinoma. It may be guarded against by partially obstructing the tracheotomy tube or bronchoscope temporarily in order to gradually reduce the obstruction. The respiratory carbon dioxide level is thus slowly lowered and respiratory failure is prevented. Manual artificial respiration may be needed in some cases.

Some helpful suggestions in tracheotomy care will be given. The tracheotomy tube should be changed every 24 hours. A sterile tube of the same size that the patient is wearing is kept at the bedside for immediate emergency replacement, as well as routine changing. One should tie the tapes snugly and securely with a square knot, since nothing is more distressing than a call to replace a coughed-out or pulled-out tube. An obturator should always be inserted when the tubes are changed, and the natural curve of the original tract should be followed to prevent trauma to the thyroid, tracheal rings, or tracheal mucosa. The obturator is often lost, and we have found it best to tie the obturator to the tape which holds the tracheotomy tube in place. It is thus always available and causes no discomfort to the patient as it dangles at one side. The inner tube should be changed every two hours, or oftener if crusts are forming within it. More rapid formation of crusts indicates insufficient humidity in the air and the need for a humidifying tent. The bronchitis is often as severe as the laryngitis in the infectious cases and the thick secretions may cause segmental or even lobar atelectasis. Constant nursing surveillance is necessary, especially during the first few days, since the blockage of the tube by a crust or a mucous plug may be as rapidly fatal as the original pathology. Solutions such as saline, an akylaryl polyether alcohol detergent (Alevaire), or crystalline trypsin (Tryptar) may be instilled by dropper or nebulization to thin the secretions. Bronchoscopy may be required to remove crusts below the tube.

Cases vary greatly in the time necessary for subsidence of the edema and the return of the temperature to normal. In some cases we have had to leave the tracheotomy tube in for as long as six weeks. Even in these cases the tracheotomy wound has healed over spontaneously and rapidly after removal of the tube.

OBSTRUCTION DUE TO INFECTION

The commonest cause of acute upper respiratory obstruction in our series is acute laryngotracheobronchitis.* It usually occurs in children, but we have had two cases in adults. This form of obstruction is seen less commonly than before the advent of antibiotics and the availability of handy electrical room humidifiers. It is usually due to a hemolytic Streptococcus of the beta group which causes a rapid laryngeal edema leading to sudden severe asphyxial symptoms. A history is usually obtained of an upper respiratory infection with rhinitis and a sore throat for 24 to 72 hours before the episode of acute obstruction. Most of the cases occur in the winter. The sharp temperature changes and the dryness of modern heated homes work in conjunction with the infection to cause edema and thickened secretions. The age of the child is usually 1½ to 7 years.

Emergency Tracheotomies for Upper Respiratory Obstruction, Jan. 1, 1949, to Jan. 1, 1954

Cause	No. Patients		
	Children	Adults	Total
Laryngotracheobronchitis	5	2	7
Carcinoma of the larynx	..	4	4
Fracture of the mandible	..	2	2
Coma	..	1	1
Carcinoma of the thyroid	..	1	1
Rupture of the trachea	1	..	1
Mediastinal and cervical emphysema	..	1	1
Neck abscess	..	1	1
Retropharyngeal abscess	1	..	1
			19

* References 4 to 6.

Often a history of previous attacks of "the croup" is obtained. The temperature is seldom above 39 C. (102.2 F.) but may in occasional cases go higher. In some cases direct laryngoscopy with aspiration of the thick secretions accumulated at the subglottic level of the larynx will relieve the obstruction enough to eliminate the need for a tracheotomy. However, the greater number of cases will require tracheotomy. Postoperatively the child is put on antibiotic therapy. We have found that many of these infections are caused by organisms resistant to penicillin or sulfones, and so we use one of the broad-spectrum antibiotics routinely. It is wise to take a secretion specimen at the time of the tracheotomy for routine culture and sensitivity studies. The child is placed in a humidified tent for the first few days to thin the secretions and prevent crusting in the tracheotomy tube, and to prevent drying of the now shortened airway. The tracheotomy tube may begin to be closed when the child can breathe with comfort lying quietly while a finger is placed over the opening of the tube for one minute. The tube opening is reduced in stages with a half cork, followed by a three-quarter cork, and finally a complete cork, each of which is worn for 24 to 48 hours.

A 6-year-old white girl (F. H.) had a sore throat and cough for two days before admission. About an hour and a half before admission the mother noted some difficulty in breathing, but the child continued to play about the house until 20 minutes before she was rushed to the hospital. On arrival there was marked stridor, cyanosis, indrawing of the supraclavicular and intercostal spaces, and muscle tremors from anoxia. The child was given nasal oxygen and rushed to the operating room on the floor above the receiving ward where within 10 minutes after arrival at the hospital an emergency tracheotomy was performed by the resident on the Broncho-Esophagology Service. No bronchoscope was used.

The rectal temperature was 38.8 C. (101.8 F.) on admission. The child was put on a liquid diet, given procaine penicillin, 150,000 units twice daily, and oxytetracycline, 250 mg. four times per day, and placed in a humidity tent. A chest x-ray was negative. The WBC was 10,950. Smear and culture showed only normal flora of the throat. On the fifth hospital day the child was removed from the humidity tent. By the seventh hospital day the temperature was normal, and the tracheotomy tube was partially blocked. On the 10th day the tracheotomy tube was removed, and the child was discharged on the 13th hospital day in good health.

Another cause of upper respiratory obstruction resulting from infection is a retropharyngeal abscess. It may cause respiratory obstruction both by compression and by the inflammatory reaction and edema which surrounds it. Today such cases are seldom seen, since the antibiotics usually limit the fulminating course of these abscesses. We have had one case during the past five years that is worthy of mention.

A 13-year-old girl (C. W.) entered the Episcopal Hospital, stating that she was standing on a chair tacking a poster on a bulletin board at school an hour and a half before. As she jumped down from the chair, a thumbtack she was holding between her lips fell backward into her throat. Since that time she had had pain in her throat and a sensation of gagging. The patient was promptly fluoroscoped and thumbtack was localized in the right pyriform fossa. Direct laryngoscopy was done, and the imbedded tack was removed two and one-half hours after the accident occurred.

The patient was kept until the next morning for observation, and it was decided not to discharge her when she developed a low-grade fever, which gradually mounted in the following week to 39.7 C. (103.5 F.) orally in spite of antibiotics. Lateral cervical x-rays showed widening of the retropharyngeal space. On the fourth hospital day an external incision and drainage of the right paraphryngeal space was done. The patient continued to run a fever, however, and she began to have some respiratory obstruction. This was due to laryngeal edema and to a huge retropharyngeal abscess which had formed. On the 10th hospital day an emergency tracheotomy was performed, and the retropharyngeal abscess was incised and drained. The tracheotomy was done not only to relieve obstruction but also to allow packing of the pharynx to prevent aspiration of the abscess contents. About 100 cc. of purulent material gushed forth and was removed. The temperature subsequently returned to normal, and the tracheotomy tube was removed on the 20th hospital day. The patient was discharged in good condition 23 days after admission.

Ludwig's angina when it spreads below the fascial limitations at the hyoid bone produces a fulminating, edematous infection, which rapidly obstructs the larynx and trachea. Most cases are seen and treated be-

fore they reach this advanced stage by incision and drainage of the submaxillary space which prevents this downward extension. Although several cases of Ludwig's angina were closely followed with the general surgical and dental services for evidence of respiratory distress, fortunately none came to tracheotomy.

Another infectious cause of upper respiratory obstruction is laryngeal diphtheria. No cases of laryngeal diphtheria were seen at the Episcopal Hospital during the five-year period reviewed. One of the authors (D.E.M.) while on military duty in Paraguay saw a considerable number of cases. Some of these were treated with the indwelling O'Dwyer tube. It requires some skill to insert these tubes and the fitting must be accurate. Since they can become clogged with diphtheritic membrane or mucous plugs or may be coughed out, it seems better to proceed with a tracheotomy in all cases of laryngeal diphtheria with signs of respiratory distress.

OBSTRUCTION DUE TO NEOPLASM

Second only to acute laryngotracheobronchitis as a cause of acute obstruction is carcinoma of the larynx.[7] Acute upper respiratory obstruction in an elderly patient without a history of injury is in most cases due to a carcinoma. Many of these cases have a history of hoarseness, pain on swallowing, tonsillar or ear pain, or neck nodes for several months before the episode of respiratory obstruction. Unfortunately they delay seeking medical attention until the acute obstruction has occurred. As soon as possible after tracheotomy a routine laryngoscopy by both mirror and direct means should be done to make an accurate diagnosis so that definitive therapy may be started. There is often an element of infection superimposed on the carcinoma. After the tracheotomy, therefore, these patients should also receive antibiotics and be put in a humidity tent. The tracheotomy in these cases should be placed as low as possible in order not to interfere with any later surgery or x-ray therapy.

Some clinics routinely do a tracheotomy in all cases of carcinoma of the larynx before beginning x-ray therapy. We do not feel that this is necessary if careful selection is made before therapy. An elective tracheotomy is done only in those cases thought likely to obstruct so that it will not be necessary to perform the tracheotomy, during the course of irradiation, through the inflamed and edematous field. If one makes careful selection, keeping in mind the decrease in airway due to irradiation edema, few cases will require emergency tracheotomy during therapy. The tracheotomy tube can usually be permanently removed when the therapy is completed and all irradiation edema has subsided.

A 77-year-old white man (L. B.) entered with the typical signs of marked upper respiratory tract obstruction. He had been seen 11 months before at this hospital for hoarseness. A direct laryngoscopy was done at that time, and a biopsy was taken of a small lesion on the right vocal cord. The report on this was squamous cell carcinoma, Grade I. A laryngofissure was advised, but the patient refused surgical therapy, as well as x-ray therapy. He was not seen again until the present admission for acute obstruction. A prompt tracheotomy was done without the aid of a bronchoscope, with relief of the dyspnea, cyanosis, and stridor. There was evidence of malnutrition. There were coarse rales over both lung fields. The patient had a temperature of 38.3 C. (100.9 F.) due to the secondary pulmonary infection. He was put on penicillin therapy.

A mirror laryngoscopy a few days later revealed a large ulcerating carcinoma of the larynx involving the entire right side and extending up to the base of the epiglottis. It almost completely blocked the airway. There were small firm bilateral cervical nodes due to metastatic involvement. X-ray therapy was given, and the patient was discharged two months after admission with the tracheotomy tube still in place. Radical neck dissection was not advised.

Compression or even invasion of the trachea by carcinoma of the thyroid is a cause of upper respiratory obstruction seen by us on several occasions. By invasion of the recurrent laryngeal nerves it may cause a bilateral cord paralysis and thus an obstruction. Asphyxial signs may develop during x-ray therapy for thyroid carcinoma when they were not previously present, owing to the added factor of irradiation edema.

ILLUSTRATIVE CASES

A 61-year-old white woman (N. H.) was admitted with stridor, cyanosis, and indrawing of the supraclavicular and intercostal spaces. She had had a thyroidectomy four years before for a presumed thyroiditis, but the pathological diagnosis of the removed gland was adenocarcinoma. She had a course of x-ray therapy following the surgical excision of the gland, and then with signs of recurrence a second course of x-ray therapy to the neck was given. The patient now entered with signs of upper respiratory obstruction due to the enlarging neck mass which was compressing the trachea.

A bronchoscope was passed immediately upon admission to give some relief from the obstruction, and oxygen was administered through the bronchoscope. A tracheotomy was done low in the neck with some difficulty owing to the size of the mass and the deviation of the trachea to the right by the predominantly left-sided mass. The bronchoscopic light served to indicate the trachea, and it was incised and a No. 5 tracheotomy tube inserted. The patient had prompt relief and was discharged to another hospital four days later for radioiodine therapy.

OBSTRUCTION DUE TO MECHANICAL CAUSES

Another source of acute upper respiratory obstruction is the dropping back of the tongue in coma.[8] In most of the cases in which the coma is of short duration an oropharyngeal airway suffices. Simple forward pressure on the mandible will maintain respiratory exchange until an airway can be secured. A nasopharyngeal tube such as that used by the anesthetists may serve better than an oropharyngeal airway. In coma which is complicated by retained secretions an airway is needed which can also be entered by a soft rubber catheter for tracheal aspirations. An endotracheal tube or tracheotomy must be utilized in these patients. An endotracheal tube should not be used for more than 24 to 36 hours, if at all possible, because of the mucosal irritation it produces leading to edema and even ulceration. A tracheotomy is best in all cases of coma in which a prompt response to therapy is not anticipated. There is a marked increase today in the number of elective tracheotomies on the medical service as the benefits of early tracheotomy are brought to the attention of the internist.

An 18-year-old white woman (E. W.) was brought into the receiving ward in coma and with no respiratory action visible. She was cyanotic, but the heart was still beating. The pupils were dilated and fixed. There was a swelling and ecchymosis above and behind the right ear. Blood and cerebrospinal fluid were trickling from the right nostril. The story given by a friend was that the patient was riding in the rain on a rumble seat of a motorcycle. The motorcycle skidded on the streetcar tracks, and the patient was thrown forward. She fell with her head bent beneath her chest. She was picked up promptly and brought to the hospital by a police rescue squad.

Artificial respiration was started, and the tongue was held forward until an endotracheal tube was inserted to maintain the airway. The patient was then placed in a mechanical respirator. The blood pressure was maintained with intravenous fluids containing levarterenol. The patient never regained consciousness, and in spite of all supportive measures died of cerebral damage 39 hours after admission. The airway was well maintained during this period by the use of the endotracheal tube.

Foreign bodies may obstruct the upper respiratory passages.[9] Obstruction of the lower respiratory passages is commonly due to a foreign body, but upper respiratory tract obstruction due to this cause is by comparison rare since most inhaled objects are small enough to pass into the major bronchi. If a foreign body does lodge in the larynx or trachea and cause obstruction, it demands immediate laryngoscopic or bronchoscopic examination and removal. The more usual source of obstruction is a large foreign body in the esophagus which causes compression of the posterior tracheal wall. Another cause may be a sharp object which pierces the hypopharynx, larynx, or trachea and leads to edema, abscess formation, or emphysema of the soft tissues. This results in an obstruction due to compression.

OBSTRUCTION DUE TO TRAUMA

Fracture of the larynx or trachea is one of the rarer causes of upper respiratory obstruction. The direct cause of the obstruction may be collapse of the tubular structure with a drawing together of its sides with inspiratory effort, a submucosal hematoma which obstructs the airway, or the escape of air into the surrounding tissues, giving an

emphysema which compresses and occludes the trachea. The last is the commonest mechanism.[10]

A 6-year-old boy (G. M.) fell from his bicycle, striking his face and neck. Immediately these areas began to swell. His parents brought him at once to the hospital, where a diagnosis was made of subcutaneous emphysema of the face, neck, and upper chest, possibly due to a rupture of the larynx or trachea. An emergency chest x-ray showed the subcutaneous emphysema and a small left pneumothorax. In about 20 minutes after admission there were signs of upper respiratory obstruction. A bronchoscope was promptly passed, and some bloody secretions were aspirated from the trachea. Because of bleeding, adequate visualization of the tracheobronchial tree could not be carried out. The bronchoscope was then removed, but the color and respirations of the child did not improve. An immediate tracheotomy was then performed. As the incision was made there was release of a large amount of subcutaneous air, and the respirations and color of the child promptly improved. The entire trachea was exposed as far as the finger could reach into the mediastinum. No tear was seen. The trachea was then opened through a midline incision in the anterior wall through tracheal rings three to five. Exposure of the posterior wall by means of a dilator revealed a laceration of the membranous portion of the trachea extending from the second tracheal ring to the sixth. The edges were well approximated on quiet respiration, and suture of the tear was not attempted. A No. 3 tracheotomy tube was inserted, and the wound was left open under a light gauze dressing. An immediate postoperative x-ray of the chest showed a partial bilateral pneumothorax, which was controlled by underwater seal drainage on the right and by needle aspiration on the left.

The patient was returned to the ward breathing easily. He was given penicillin and streptomycin. One week later his subcutaneous emphysema had decreased 75%, but he was still entirely dependent upon the tracheotomy as an airway. On the 14th hospital day the trachea was inspected by bronchoscopy, and the laceration was well healed without evidence of stenosis. The tracheotomy tube was removed on the same day, and the patient was discharged two days later.

Mediastinal emphysema may spread upward and gradually cause an upper respiratory obstruction of varying degrees.[9] This phenomenon may develop after chest trauma, a tension pneumothorax of a spontaneous or traumatic nature, chest surgery, or fracture of the trachea and bronchi. The mediastinal emphysema may be due to air in the pleural space under pressure which enters the mediastinum through the thin hilar pleura or by dissection of the air from ruptured alveoli along the bronchioles and bronchi into the mediastinum. This results not only in respiratory obstruction but also in poor venous return due to compression of the low pressure great veins in the thorax. The correct therapy in all of these cases is an early tracheotomy, which provides an airway and also a mediastinotomy to relieve the air which is accumulating in the mediastinal space. It eliminates the increased intra-alveolar pressure caused by closure of the larynx in grunting respirations and in coughing. When the incision is made, an audible and visible bubbling of air from the subcutaneous tissues and from the depths of the incision occurs. The egress of air is aided if blunt finger dissection is carried down into the superior mediastinum along the anterior and lateral aspects of the trachea at the time of the tracheotomy. Antibiotics should be given to prevent the spread of infection along these opened planes. The tracheotomy tube should not be removed until the mediastinal emphysema is gone, as shown by x-ray, and the subcutaneous emphysema has disappeared.

A 75-year-old white man (H. G.) was admitted to the receiving ward in a comatose state, with fractures of the left ankle, left femur, and four ribs on the left. There was some subcutaneous emphysema of the neck and upper chest. He had a scalp laceration and was thought possibly to have a skull fracture. He had been struck by a car about 15 minutes before admission. He was treated for shock and eight hours after admission regained consciousness. By 18 hours after admission the subcutaneous emphysema was more extensive, and a chest x-ray showed marked mediastinal emphysema. There were moderate symptoms of upper respiratory tract obstruction, and in order to prevent progression of the obstruction, to provide a means of aspirating the bronchial secretions, and to relieve the mediastinal emphysema, a tracheotomy was done. Air bubbled from the wound as the incision was made and even more air came out as dissection was carried down along the trachea into the mediastinum. A No. 6 tracheotomy tube was inserted, and the respirations promptly improved. The patient died one week later of a pulmonary embolus.

Fractures of the mandible with marked contusion of the soft tissues of the floor of the mouth and neck may result in edema and hematoma formation necessitating a tracheotomy. We have had one case in which it had to be done as an emergency procedure upon arrival at the hospital, one case in which it had to be done 11 hours later, and several cases in which it was done prophylactically because it was thought the edema following operative reduction of the mandibular fragments might tip the balance of an already edematous area over to a complete respiratory obstruction.

A 53-year-old white man (J. C.) was intoxicated and fell from a third-floor window. When brought to the receiving ward he was in a semicomatose state and had some respiratory stridor. There was a comminuted fracture of the mandible and fractures of the skull, pelvis, ribs, and right forearm. The edema and hematoma formation about the mandible and upper neck gradually grew larger and the respirations became more difficult. Eleven hours after admission an emergency tracheotomy was performed and the respirations promptly became normal. Bronchoscopy was done on the 12th hospital day via the tracheotomy stoma for removal of inspissated secretions that could not be aspirated through the tracheotomy tube. Five weeks after admission open reduction and plating of the mandibular fractures was performed. In the eighth hospital week the tracheotomy tube was removed, and three weeks later he was discharged to his home with his fractures healed and in fair general health.

Acute obstruction of the upper respiratory tract may develop from edema in the early postoperative period after surgery of the tongue, floor of the mouth, mandible, or hypopharynx. We have had no such acute obstruction in our series because prophylactic tracheotomies were done in all instances in which postoperative obstruction was a possibility.

OBSTRUCTION DUE TO NERVE INVOLVEMENT

Bilateral recurrent nerve paralysis may be due to toxins affecting the nerves or more commonly to operative injury at the time of thyroidectomy.[13] A preoperative examination of the cords should be done on all patients undergoing thyroidectomy, and the anesthesiologist should examine the cords by direct laryngoscopy at the time he removes the endotracheal tube. This will prevent an emergency situation from developing when the patient arrives on the ward and the adducted cords cause acute respiratory obstruction. If there is any question of division or injury to the recurrent laryngeal nerves, the surgeon should proceed with a tracheotomy in the operating room. The trachea is exposed; it adds little to the operative time, and the scar is no more than the usual transverse curved thyroidectomy scar. This precaution will save the surgeon many later worries.

Bulbar poliomyelitis requires a tracheotomy because of the vocal cord paralysis and because of the retained secretions which need aspiration. No tracheotomies were performed for this reason at Episcopal Hospital because all such cases are transferred immediately upon diagnosis to the city hospital for contagious diseases. Several large series have been reported elsewhere of tracheotomy in poliomyelitis.[14]

Tetanus is another possible cause of acute upper respiratory obstruction due to the adductor spasm of the vocal cords that may accompany each generalized tetanic muscle spasm. Tracheotomy should be done only if urgently needed because of attendant irritation which incites further spasm of the cords and entire musculature. Several cases of tetanus were treated during the five-year period, but none came to tracheotomy.

UNUSUAL CAUSES OF OBSTRUCTION

Angioneurotic edema may necessitate a tracheotomy to relieve a fulminating edema of the upper respiratory passages. The early and judicious use of epinephrine, antihistamines, and more recently cortisone has prevented the need of tracheotomy in these cases in our series.

Other rare causes of upper respiratory obstruction are tuberculous laryngitis and a syphilitic gumma of the larynx. Several cases of tuberculous laryngitis were treated, but none caused acute obstruction. One syphilitic gumma of the larynx was also seen but did not necessitate a tracheotomy. Pa-

tients having a syphilitic gumma of the larynx should be hospitalized during antisyphilitic therapy to watch for acute obstruction from the edema of the Herxheimer reaction in the gumma. A large substernal thyroid and Riedel's struma may cause compression of the trachea and obstruction. The trachea may collapse and cause obstruction after removal of a large substernal thyroid even though there was no obstruction before removal. This is due to weakening and collapse of the tracheal rings.

CONCLUSIONS

1. There should be a tracheotomy tray ready in the receiving ward of all general hospitals for upper respiratory obstruction emergencies.

2. One service should be responsible for all tracheotomies and their care in the hospital.

3. Residents and interns on all services should be capable of recognizing the need for and doing emergency tracheotomies.

4. It must be reemphasized that delay in diagnosis and therapy of upper respiratory obstruction leads to haste, poor preparation, operating difficulties, patient fatigue, post-tracheotomy apnea, and brain damage from anoxia. These are all factors which contribute to death in acute obstruction of the upper respiratory tract.

5. One should err on the side of too early and too many tracheotomies rather than too late and too few. Some of our own emergency tracheotomies should have been elective orderly tracheotomies.

6. The field of usefulness of tracheotomy is continuing to widen.

SUMMARY

The various causes of acute upper respiratory tract obstruction are given, and cases illustrative of the commoner causes, selected from the files of the Episcopal Hospital, are presented. A survey was made of the cases needing tracheotomy for acute upper respiratory tract obstruction during a five-year period in the moderate-sized general hospital. The need of a receiving ward prepared to recognize and to treat the various acute obstructions of the upper respiratory tract is emphasized.

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RECENT TRENDS IN RHINOPLASTIC SURGERY

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THE ORTHODOX rhinoplasty has been a utility of value to relatively few surgeons: 1. Because of its fortuitous nature. An operation based for its success on the excision of skeletal tissue must carry the penalty of asymmetrical healing of the overlying soft parts. Thus, a nose well modeled at the time of surgery too often months later will appear less satisfactory—an eventuality which the most scrupulous attention to technical detail cannot forestall. 2. Because success is possible only after prolonged trial and error. The concept provides no accurate gauge as to the amount of bone and cartilage to be removed or added.

To overcome these faults and thus make the operation less individual, we tried shifting emphasis back and forth from one aspect of the procedure to another. As a result, techniques were developed which at first seemed to be sound but later proved disappointing. We finally came to the conclusion that the solution of the problem lay rather in concept than in technique.

The purpose of this paper is to present an epitome of our progress.* Those who have contributed to the fabric of the present concept are so numerous that it would be difficult, if not impossible, to identify the specific threads furnished by any one of them. As Ogilvie [5] aptly remarks: "To suggest that any surgical outlook is personal is in many ways an impertinence, for every surgeon learns from the atmosphere of discussion and criticism in which he moves from his seniors and still more from his juniors."

* References 2 to 4, 6, 8, and 11 to 14.

MANAGEMENT

Details of technique and special expedients to meet unusual problems are omitted.

From a surgical standpoint, we find it practical to visualize the nose as a recumbent pyramid divided into three parts: the apex, forming with the forehead an angle of 125 degrees; the body, comprising the central part; the base, forming with the upper lip an angle of 90 to 110 degrees. From root to tip the pyramid on cross section represents a series of gradually increasing triangles.[6] The

Fig. 1.—Parallel perpendicular lines dropped from inner canthi should be tangential to alae.

combined apices constitute the dorsum, the sides the lateral walls, and the bases form a plane bounded by two parallel vertical lines dropped from the inner canthi at right angles to the intercanthal line. Normally, the alae will be tangent to these lines (Fig. 1).

Each step of the operation requires correction of the part in relation to contiguous facial structures; and since this results in a disturbed relationship between the nasal elements, there is always need for a secondary

reassembling of these components for the purpose of restoring their former conformation. For example, after the removal of a hump, the cross sectional triangle has been converted into a trapezoid, which must be transformed once again into a triangle, and after shortening of the nose, the resultant hanging septum must be corrected.

The steps in the correction of a nasal deformity are carried out in the following order:

I. Preoperative sedation, anesthesia, uncovering of nasal skeleton, and cutting of lower lateral cartilages at their angles

II. Modeling of base of pyramid (lower cartilaginous vault)
- A. Reconstruction of columella
  1. Positioning of columellar-labial junction
  2. Reconstruction of columellar length
  3. Reconstruction of columellar inclination
- B. Reconstruction of basal triangle
  1. Reconstruction of back wall of triangle (dorsal wall; base of triangle)
  2. Reconstruction of side walls (alae)
  3. Reconstruction of apex of lobule (tip)

III. Modeling of apex of pyramid (nasal root)
- A. Side walls too long
- B. Side walls too short
- C. Simulated root deformities due to faults in frontal bone
  1. Receding forehead
  2. Projecting forehead

IV. Modeling of body of pyramid (osseous and upper cartilaginous vault)
- A. Undue projection (hump)
- B. Deficient projection (saddle)
- C. Deflection
- D. Broad nose
- E. Septal deflections

V. Dressing

I. Preoperative Sedation, Anesthesia, Uncovering of the Nasal Skeleton, and Cutting of the Lower Lateral Cartilages at Their Angles

The procedures of giving preoperative sedatives, administering anesthesia, uncovering the nasal skeleton, and cutting the lower lateral cartilages are accomplished in the usual manner.

II. Modeling of Base of Pyramid (Lower Cartilaginous Vault)

The rhinoplasty is begun with the modeling of the base, for this segment furnishes an index to the faults in the balance of the nose.

We have found it most practical to carry out the steps in the following order:

A. Reconstruction of Columella (Fig. 2).—Figure 2 illustrates the steps in reconstruction of the columella.

1. Positioning of Columellar-Labial Junction: The columella should join the lip at a point 2 to 3 mm. below the level of the alar-labial junction (Fig. 2*A*). If the junction between columella and lip is too low, it is raised by a cautious excision of the caudo-dorsal portion of the septum and/or nasal spine, and the parts are slid up into the space thus created. If the junction is retracted, it is brought out at the expense of the columellar width as follows: A raw surface is created at the base of the columella by a separation of the walls with scissors, and a mattress suture is passed and tied to bring about the desired projection.[2] If there is still a lack of projection, the lip is buckled as described below, or a graft modeled from the hump or removed from the septum is introduced.

2. Reconstruction of Columellar Length (Fig. 2*B*): The columella should be 2 to 3 mm. longer than the vertical length of the lip. If the columella is too long, it is shortened by a transfer of the excess columellar tissue into the lip. If too short, it is lengthened at the expense of the lip. The technique has been described elsewhere.† Briefly, one needle of a double-armed suture enters the skin of the columella and is pushed through to emerge from one of the columellar walls. It is then carried through the dorsocaudal (posteroinferior) part of the septum and brought out through the naris. The other needle is carried through the original point of entry, brought out through the other columellar wall, and the ends are tied. If the

† References 2 and 9.

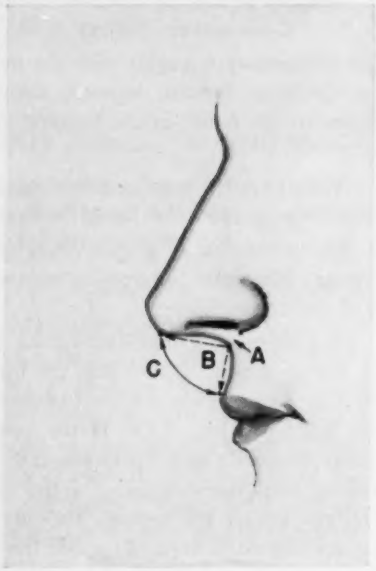


Fig. 2.—Reconstruction of columella. *A*, columella should join lip at point 2 to 3 mm. below alarlabial junction. *B*, columella should be 2 to 3 mm. longer than vertical length of lip. *C*, columella should form angle with lip of 90 to 95 degrees in men and 100 to 110 degrees in women.

columella is too long, the needle is introduced on the columellar site; if too short, on the labial site.

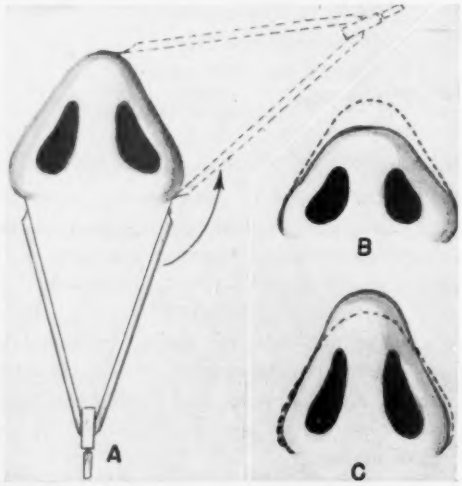
3. Reconstruction of Columellar Inclination (Shortening of Nose) (Fig. 2*C*): In a nose of normal length the slope of the nares forms an angle with the lip of 90 to 95 degrees in men and 100 to 110 degrees in women, provided the lip is normal. The columella is grasped between thumb and forefinger, and with an upward (cephalad) and backward (dorsad) motion the lower cartilaginous vault is telescoped over the upper until the desired relationship between lip and nares is obtained. With the aponeurosis between the upper and lower lateral cartilages cut, this position is automatically maintained by the contraction of the overlying skin.

The long nose has thus been converted into a nose of normal length with a secondary deformity consisting of a hanging columella due to the projecting septum. This is now attended to. The columella is pushed to one side of the septum and raised until it comes to lie 2 to 3 mm. below the alar margin. A scratch is made at this level on the septum, and the part below is excised.[3]

B. Reconstruction of Basal Triangle.—Viewed from below, the base of the pyramid in a normal nose forms an equilateral triangle in which the interalar distance is equal to the length of the side walls. This relationship is determined with calipers (Fig. 3). The points are placed at the junctions of the alae with the lip. The instrument is locked and one limb swung to the midline. If it falls exactly on the center of the tip, the projection is normal; if it comes to lie below the center, the tip is unduly projecting; and if above, receding.

1. Reconstruction of Back Wall of Triangle (Dorsal Wall; Base of Triangle): If the alae project beyond the aforementioned parallel perpendiculars dropped from the inner canthi (Fig. 1), the base of the triangle is too wide and must be reduced to bring the alae within the canthal lines. The technique has been described elsewhere.[2] Briefly, the alae are cut through where they abut the lip, and through these incisions the base of

Fig. 3.—Measurement of base of nose with calipers. *A*, Points of calipers placed at junction of alae with lip. Dotted line indicates one point of calipers swung to midline. If it falls on center of tip, projection is normal. *B*, If point of calipers lies above center, tip is unduly receding. *C*, If point of calipers lies below center, tip is unduly projecting.



the nose is separated from its attachment to the bone. An absorbable surgical suture threaded through two straight needles is passed through the tissues, entered through one incision, and brought out through the other. The suture is tightened, to secure the desired width, and tied. This suture also serves to project the septolabial junction and elongate the columella.[2] The two alar incisions are closed with two or three atraumatic sutures.

2. Reconstruction of Side Walls (Alae): If the lateral walls are misshapen and/or of abnormal length, the lateral crura are delivered in the usual manner,[8] and the soft tissue over the cartilage is removed. A small flap of vestibular skin is raised from the terminal end of the cartilage, its size depending on how much of the crura will overlap. This prevents the burying of epithelium. In addition, the small flap provides a cover for the raw area at the apex of the vestibule. The balance of the cartilage is shaved and/or cross hatched until the spring has been completely destroyed.[2] The vestibular surface of the flap is examined (Fig. 4). Usually there is enough raw area to permit an adequate adhesion between the upper and lower cartilaginous vaults. Should it be deemed advisable to secure broader adhesion, the vestibular skin is undermined (but not removed). It will automatically retract, to produce the desired result. Further modeling is done during the tip reconstruction.

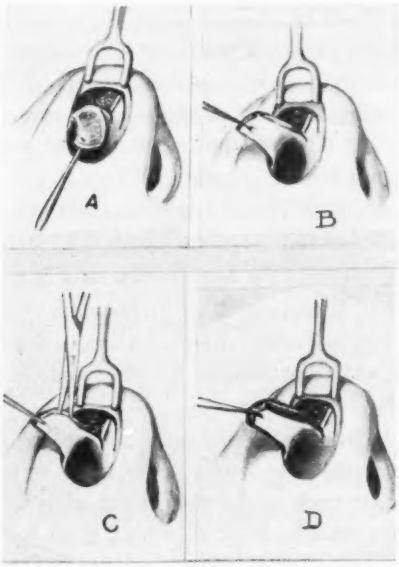


Fig. 4.—Examination of vestibular surface of flap. *A*, Lateral crus delivered, raw surface facing outward. *B*, Lateral crus turned over, to bring vestibular surface into view. Note amount of raw surface for adhesion between upper and lower cartilaginous vaults. *C*, To secure broader adhesion, vestibular skin undermined with scissors but not removed. *D*, Greater amount of raw surface for adhesion visible.

3. Reconstruction of Apex of Lobule (Tip): The cut ends of the mesial crura are delivered. If cleft or separated, they are brought together with an absorbable surgical (gut) suture. Occasionally the intervening soft tissue must be removed before approximation can be obtained.

The ends of the lateral crura are then grasped in turn with forceps and placed over the mesial crura, the two ends being made to abut or overlap each other.[2] With all the parts mobilized (cover, support, and lining), the lobule is modeled with the fingers, as one would shape a piece of clay, until the desired contour has been attained.

The normal "break" above the tip is created at the conclusion of the operation by raising the ends of the lateral crura and draping the soft tissues of the lobule over them in the following manner: A pocket is made between the skin and mesial crura. Into this pocket is inserted a strut consisting of part of the removed hump or septal cartilage. The strut is placed in such a manner as to force the ends of the lateral crura upward sufficiently to attain the proper "break" between the tip and the dorsum.[2]

III. Modeling of Apex of Pyramid (Nasal Root)

For surgical purposes the apex, or root, constitutes the upper one-quarter of the nasal pyramid. In a normal nose the distance from the inner canthus to the midpoint of the frontonasal articulation (nasion) should measure approximately three-quarters of the length of the base. Unlike the balance of the nose, the root is a solid block of bone all the way back to the cribriform plate. This makes

it impossible to narrow the base by shifting the walls medialward. (We have tried to chisel out the center of the block to create room for shifting, but found the procedure to be ineffectual, because not enuogh bone can be safely sacrificed to allow the side walls to meet.) Nor can the projection of the side walls be reduced by their displacement into the nasal fossae. Being of solid structure, however, the apex of the pyramid can be shaped by a chiseling of the outer surface.

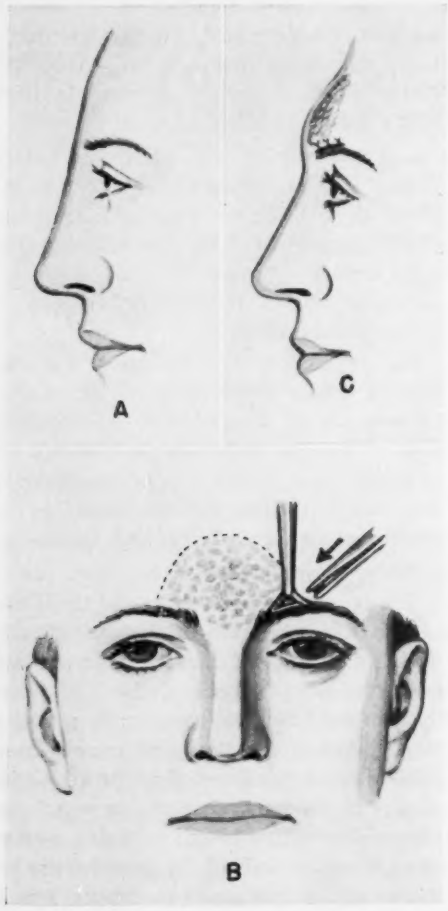


Fig. 5.—Unduly shallow nasofrontal angle (Greek profile). *A*, Due to receding forehead. *B*, Incision made in eyebrow. Dotted line indicates amount of undermining. Forceps shown introducing fragmented cartilage or bone. *C*, Profile view of completed operation. Wound in eyebrow closed.

Since the back wall of this section is a fixed measurement (intercanthal line), it cannot be altered. Only the side walls are subject to modeling.

A. Side Walls Too Long.—If the side walls are too long, a saw cut is made at the desired level on either side in the manner employed for the removal of a hump. With a chisel, these grooves are deepened to meet below, and the bone is rocked out with a hemostat. If the projection is entirely nasal, it will come away easily in one piece at the nasofrontal articulation; if it is due to the nasal process of the frontal bone, some difficulty will be encountered, and the bone will require piecemeal resection. The root is then made to resume its pyramidal contour by a chiseling-down of the sides. A practical expedient is to cut the root down and replace it with a modeled graft.

B. Side Walls Too Short.—If the side walls are too short, the solution is a simple one, namely, the introduction of a graft.

C. Simulated Root Deformities Due to Faults in Frontal Bone.—In a normal profile the angle between the forehead and the root should be 125 degrees.

1. Receding Forehead: A receding forehead may give rise to too shallow an angle. Under such circumstances the glabellar region must be built up with a graft to form a normal angle (Fig. 5). An incision is made in the eyebrow and a pocket created over the glabella in the plane immediately above the pericranium. Chips of cancellous bone or cartilage are introduced and manipulated with the fingers until the desired nasofrontal angle is obtained. The small incision in the eyebrow is closed with atraumatic sutures.

2. Projecting Forehead: A projecting frontal bone may cause the angle to be too deep. Correction of this deformity still awaits a satisfactory solution. With our present thinking, we feel that the amount of surgery required on the frontal bone would not be justified by the indication.

Fig. 6.—Normal projection of body of pyramid ascertained by straight line drawn from root to tip. Any part of dorsum above this line requires removal.

IV. Modeling of Body of Pyramid (Osseous and Upper Cartilaginous Vault)

The body of the pyramid is composed of a thin shell of bone and cartilage, divided by a fixed bony and cartilaginous central partition (septum). Here the anatomy is such that the walls can readily be shifted medialward or backward.

In this segment correction may be necessary for one or more of the following deformities:

A. Undue Projection (Hump).—Whereas formerly we first reduced the profile projection and then modeled the base to harmonize with the rest of the nose, we now facilitate the procedure and at the same time obtain greater precision by reversing the process. The steps in the reconstruction comprise (1) reduction of the profile projection and (2) reconversion of the resulting trapezoid into a triangle by an inclination of the walls medialward. The base and apex of the pyramid having been corrected, the proper projection of the body of the pyramid can be easily ascertained by a straight line drawn with methylene blue on the skin on either side of the nose from root to tip (Fig. 6). Any part of the dorsum appearing above these lines requires removal.

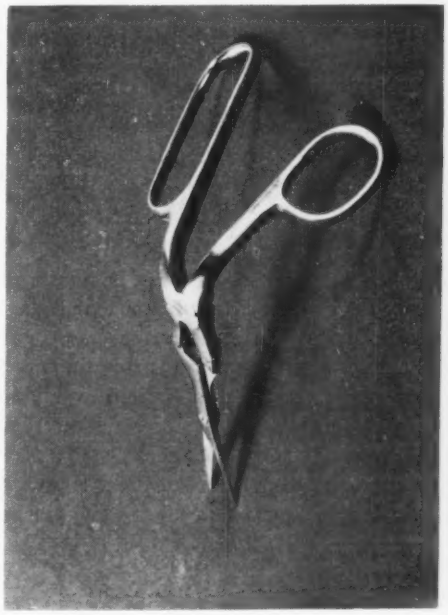
The cross sectional trapezoid resulting from the hump removal is converted into a triangle by means of osteotomies through the frontal processes of the maxillae and a tilting of the lateral walls medialward. Any minor disproportion is corrected by an elevation or depression of the lateral walls above or below the maxillae with a Walsham forceps.

Perhaps a clearer idea of the procedure may be obtained by comparison with the use of the microscope, wherein the excision of the hump represents the coarse adjustment, and the elevation or depression of the nasal bones with the Walsham forceps to obtain a precise profile outline, the fine adjustment.‡

The soft structures are elevated with an angulated retractor and all irregularities cut away. If the osseous septum projects, it is either chiseled or bitten off with an angulated bone-cutting scissors (Fig. 7). Protruding septal cartilage is shaved away with a knife

‡ Cottle.[10] Laff, H. L.: Hump Removal; Kirchner, J. A.: Cartilaginous Hump; Ogura, J. H.: Hump Removal with Kazanjian Forceps; Williams, R. I.: Technic of Vestibular Osteotomy, in Cottle.[10]

Fig. 7.—Specially designed double-action bone scissors. (Manufactured by H. E. Cullman, 316 Fifth Ave., New York, and S. G. Krebs, 351 Second Ave., New York.)



or cut down with angulated cartilage scissors. If the upper lateral cartilages are misshapen, their spring is eliminated by cross hatching, after which they are molded into the desired form. If the cartilages are too long, the excess is excised.

B. Deficient Projection.—The part is built out with a cancellous bone graft in the usual manner.[11]

C. Deflection.—If the body of the pyramid is deflected, the broad side is reduced to equal the short side in the usual manner,[6] osteotomies are made through the frontal processes, and the walls are shifted to the midline.

D. Broad Nose.—The correction depends on the cause. If the base is broad but the lateral walls are of proper length, the base is narrowed as follows: The spring of the arch is broken, osteotomies are performed through the frontal processes, and the lateral walls are shifted medially. To prevent postoperative broadening, an instrument with a double loop is introduced between the skin and skeleton, and a tantalum suture is passed through the loop. By traction on the instrument, the wire is drawn into the nasal cavity. One end of the wire is then threaded on a needle and used to approximate the columella to the septum.[6] If the base is of normal width but the side walls are too short (Negroid nose, flat nose), the nose is built up with a graft.[11]

E. Septal Deflections.—The management of the septum in relation to the rhinoplasty has been discussed elsewhere.§

V. Dressing

The rhinoplastic dressing has been described elsewhere.‖ Briefly, the alar flaps are held in place with a petrolatum gauze pack. The nose is painted with benzoin tincture. A strip of adhesive plaster is laid around the base of the lobule and a second piece just behind the strut. The adhesive plaster is pinched up with a hemostat to force the strut into a more desirable position. The pinched-up tuck is cut away and the plaster reinforced with another strip. A pear-shaped piece of adhesive plaster is then laid over the nose, the base lying along the "break" between the dorsum and tip. This is reinforced with other strips. All tension on the tissues is eliminated by a sling extending around the lobule and anchored to a point on the forehead. The adhesive serves as a mold in which the tissues heal, similarly to the congealing of jelly poured into a container. To protect the patient against himself, the adhesive is covered with a stent dressing held in place with additional strips of adhesive. The outer dressing is not disturbed until healing has taken place, i. e., in a week or 10 days. The packing is left in place for three or four days, after which time it will come away easily. If it sticks, it can be left undisturbed for a day or two longer.

SUMMARY

Rhinoplasty today has a wider application than ever before as a result of a more solid foundation in concept. The sequence of operative steps for the correction of a nasal deformity is outlined. The use of certain precise measurements is suggested. Since the principle is based on a reassembling of the nasal components rather than on their sacrifice, the procedure not only adds an element of safety but also assures a greater predictability of end-results than heretofore.

307 Second Ave. (3).

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SELECTIVE COCHLEAR DESTRUCTION, COCHLEAR POTENTIALS, AND HEARING LOSS

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STUDIES in which selected portions of the cochlea are mechanically destroyed have long been a primary source of data for theories of hearing. From the very earliest work the attempt has been to demonstrate that the perception of pitch can be accounted for in the cochlea itself. In order to attack the problem, numerous techniques have been utilized to induce cochlear lesions, and various tests have been introduced to measure the resultant loss in sensitivity. Some 70 years after the initial studies were undertaken, there is still not complete agreement on how to interpret these and subsequent findings. The early work on this problem suffered from lack of precision in measurement at both the stimulus and response ends. With the development of electronic methods of handling sound and the discovery of cochlea potentials, these faults were remedied, but there still remained the question of the relationship between the electrophysiology of the ear and hearing. For a brief but cogent review of the literature through 1948 the reader is referred to Wever.[1]

In the recent past Schuknecht and Neff,[2] Schuknecht and Sutton,[3] and Gross [4] have reopened the problem of cochlear lesions induced mechanically and their effect on auditory sensitivity. These investigators all used conditioned-avoidance techniques to measure hearing loss. When injury was confined to the basal end of the cochlea, an abrupt loss to high-tone sensitivity was reported.[3] When apical lesions were produced, or when at least the basal coil was intact, the reports showed much more widespread losses throughout the audible range.*

The present study, well in progress before the above-mentioned papers were reported, deals with the problem of midcochlea and equal lesions. The attempt is made here to clarify the existing literature by a study which would correlate lesions at various places along the length of the basilar membrane with both electrophysiological and behavioral indices of sensitivity.

METHOD

Guinea pigs with normal hearing as judged by the Preyer reflex were used as subjects. For convenience the experimental procedure is described in five sections.

1. *Initial Surgery.*—Each animal was anesthetized with veterinary pentobarbital (Nembutal)* (dosage, 0.66 cc. per 100 gm. per body weight). Under aseptic conditions, a ventral approach to the auditory bulla was made through the right side of the neck, and the bulla was opened to expose the cochlea. A perforation in the wall of a particular turn of the cochlea was made with a hand drill 0.2 mm. in diameter. A fine wire with a cutting edge was passed through the opening to injure all structures in the immediate region. The incision was then sutured and the animal allowed at least three months to recover.

2. *Conditioning.*—The conditioned respiratory response was used to determine each animal's sensitivity to tone. Testing was carried out in a soundproof, double-walled chamber, 48 in. (122 cm.) deep, 55¾ in. (142 cm.) high, and 96 in. (244 cm.) long. Entry to the box was provided by a movable window, composed mainly of three thicknesses of ¼ in. (0.6 cm.) plate glass. This window also served as a means of observing the animal during the experimental trials.

During an experimental session an animal was wrapped in an inflated pneumatic sleeve and suspended from the ceiling of the chamber. Copper electrodes were fastened to the hind feet. The use of the sling-suspension technique kept the animal's

From the Princeton Psychological Laboratory. This research was supported in part by the Office of Naval Research under contract N6-onr-270, T.O.3, Project NR 140-322, and also by Higgins Funds allotted to Princeton University.

* References 2 and 4.

head at a constant distance, 13 in. (33 cm.), from the speaker, University type PA 30, which was fixed in the ceiling of the box. The speaker output was adjusted to a constant level by use of an output meter connected to the circuit.

Sound was provided by a General radio oscillator, type 1304 A. Attenuators in the circuit gave control of intensity by steps of 1 db.

Variations in breathing induced changes in air pressure in the pneumatic sleeve which clothed the animal. These changes were transmitted to a tambour, which activated an attached paper flag. The flag in turn scanned a photoelectric cell amplifier, whose output activated a Brush electromagnetic penmotor, type BL 092 A. Records were made on tape moving at the rate of 0.64 in. per second.

In the training sequence the animal was presented randomly with 10 tones between the limits 200 to 10000 cycles. Initially the tones were all well above threshold, but intensity was varied in the later stages of training. The duration of the tone was kept between two and six seconds, and at its final instant a current was delivered to the hind legs at an intensity sufficient to disturb the animal. Accompanying the shock was the sound of a buzzer. Within a short time anticipatory responses were evident at the onset of the tone. At this point the shock was discontinued as a regular reinforcer. The buzzer sound continued to follow the onset of the tone and was occasionally paired with shock.

The animal's response was evaluated in two ways. In addition to the electrical recording of breathing changes in response to the introduction of a tone, changes in gross behavior were noted independently. Each animal developed a characteristic pattern of response both to "tone" and to "no tone" conditions. The breathing records were evaluated separately and were checked against the behavioral observations. In almost all cases the area of agreement was within 10 db.

In the measurement of thresholds a modified method of limits was used. Ascending and descending series in 10-db. steps were given. In this way a specific intensity range for further investigation was delimited. This range included that intensity level to which there was always a positive response and that level to which the animal never responded in a positive fashion. Within this range systematic exploration was carried out in steps of 5, 2, and, sometimes, 1 db. The threshold was taken as the mean, or 50% point, of positive and negative responses from both the breathing and behavioral activities.

At the end of the conditioning phase there was, for each animal, a 10-tone audiogram (200 to 10000 cycles), which had been checked on two separate occasions.

3. *Destruction of Noninjured Ears.*—Under aseptic conditions, each animal was again anesthetized with veterinary pentobarbital. A lateral approach was made to the auditory bulla cavity, exposing the round-window membrane. A curved injection needle was passed through the membrane into the basal turn of the cochlea, and pressure was applied to crack through the cochlear wall. Destruction was observed to be complete in all cases when in a later phase of the experiment the temporal bone was removed from the skull. The incision was sutured, and a minimum of two weeks was allowed before proceeding to the next stage of the experiment.

4. *The Determination of a Second Audiogram.*—Two or three days of habituation to the apparatus were allowed. During this time a random selection of tones at high intensities was presented. The responses were immediate and were in keeping with the kinds of response given before the intact ear was destroyed. Using the same procedure outlined earlier, a second audiogram was determined for the same range of tones.

5. *Histological Preparation.*—The animals were sacrificed by an intravital perfusion of a fixative solution. The stages of dehydration and embedding, the thickness of sections, the staining solutions used, and the techniques for graphic reconstruction and evaluation of structures have all been described previously.† There was one deviation from these previous procedures: the sections were cut at a thickness of 33 μ and every third section was used in the series.

RESULTS

A study of this type involves many technical hazards. Of an original population of over 30, nine experimental animals survived.‡ Of these, we were able to get conditioning records of seven, cochlear potentials and histological evaluation on all. Although every effort was made to induce lesions on specific turns of the cochlea, the histological findings reveal that this was not the case. In almost all instances, in addition to the intended injury, there was damage to structures located apically to the point of entry. The picture in the injured areas was mostly severe. Oftentimes the basilar membrane was

† References 5 and 6.

‡ One control animal was carried through the procedure. This animal showed no hearing defect nor any loss in electrical sensitivity as a result of the operative procedure, i. e., opening the auditory bulla.

ripped from its moorings, and in some cases the modiolus was cracked. Large areas were seen in which both the auditory nerve fibers and primary ganglion cells supplying those areas were absent. Lesser injury usually consisted of extensive changes in the hair cells and supporting structures of the organ of Corti and some degeneration of the accompanying nerve fibers and ganglion cells.

The histological findings can be separated into two distinct categories: those ears in which there is injury from the second turn to the apex, beginning roughly 8 mm. from the basal end, and those ears in which injury is confined to more apical regions, starting approximately 13 mm. from the base of the cochlea.

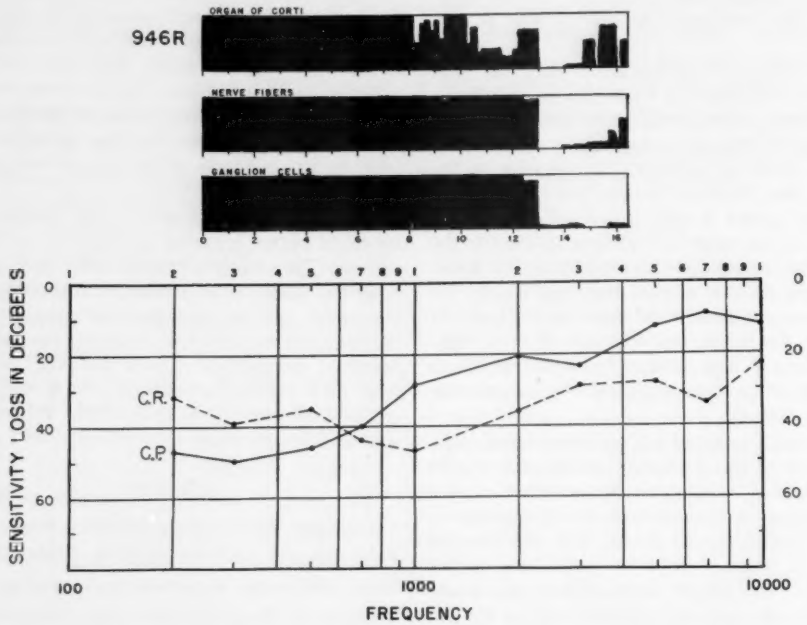

Fig. 1.—The histological picture for a typical member of the middle and apical lesion group is in the upper part of the figure. The white space indicates injury. The scale in the horizontal dimension represents distance in millimeters in the cochlea proceeding from the basal coil. In the vertical dimension the degree of injury is represented. Below is the mean sensitivity loss for the entire group measured in two ways. C.R. stands for conditioned response data and C.P. for cochlear potention measurement.

Let us first examine the ears in which the more extensive damage was produced. In Figure 1 we have accumulated all the data relevent to this group. The uppermost portion of the figure contains a graphic representation of the cochlear structures for a typical animal of this group. What we find here is that the organ of Corti damage begins at 8.2 mm. from the basal end and continues on to the apex. At first the injury is moderate, and most of the structures, including some of the hair cells, are still intact. Around the 10-mm. point the injury becomes serious and continues in this way up to the very apex, where hair cells and supporting structures are again seen. The nerve-fiber and ganglion-cell distributions are most severely affected from 13 mm. to the apex. This condition deviates slightly from most of the other cases, since nerve-fiber and ganglion-cell injuries usually followed much more closely the pattern of destruction found in the organ of Corti. In the other ears in this group the picture was much the same. The basal turn, or at least the first 7 mm. of it, was intact, while the remainder of the cochlea showed injury.

Directly below the histological results is presented the mean sensitivity curves for all animals in the group. The solid curve, based on five cases, represents the loss in cochlea potentials after injury, while the broken curve, based on four cases, indicates the loss in sensitivity measured by the conditioned response technique. From both curves it is apparent that all tones are affected to some extent when the middle and apical portions of the cochlea are injured. In the curve measuring electrical sensitivity, it is plain that the response to the lower tones is much more impaired than the response to the higher tones tested. The change is progressive and covers a range of some 4 db. This

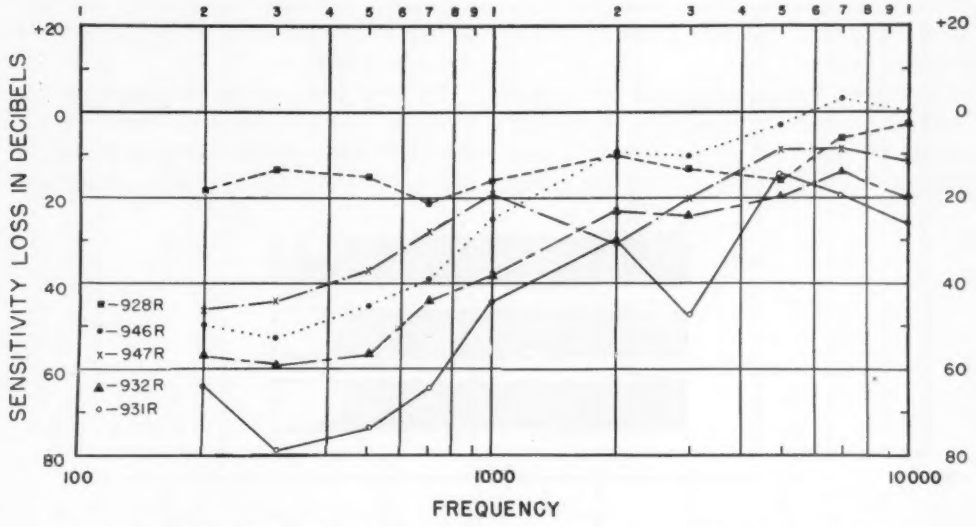

Fig. 2.—Cochlear potential loss for each animal in the middle and apical lesion group.

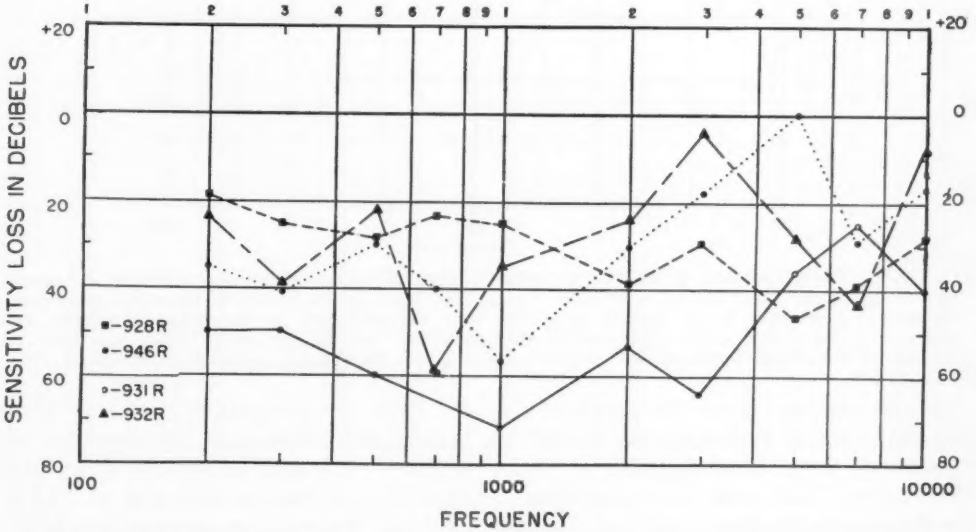

Fig. 3.—Individual hearing loss in the middle and apical lesion group measured by conditioning techniques.

same condition does not obtain when the behavioral data are evaluated. The curve for loss of sensitivity is much more uniform, with the greatest dip occurring around 1000 cycles. The general observation might still be made that the response to the higher tones is less impaired, but this difference is extremely small.

In Figures 2 and 3 we present the original data from which the composite, or average, curves are drawn. Here one may get a clear picture of the variability within the group, and one may also assess the adequacy of a single figure to represent this variability. In Figure 2 the electrophysiological results are shown. Each curve depicts the loss in cochlea potentials for a particular animal after injury. Individual curves of sensitivity loss measured behaviorally are shown in Figure 3. In general we might say that the cochlear potential curves are similar to each other in shape, and a single trend line may easily be drawn. The conditioned-response curves are somewhat more variable, especially when high-tone loss is considered. In three of the four cases high-tone loss is not so serious for at least some part of the upper frequency range. Yet in all cases there is a general high-tone impairment, and this is most clearly portrayed in the group curve shown in Figure 1.

We shall now turn to the results of the group in which injury was located in the third and fourth cochlear turns, in the region of the apex. A typical histological picture and the mean loss in sensitivity measured electrically and behaviorally are presented in Figure 4. The four ears in this group had organ of Corti damage starting at 12.6, 13.6, 15.8, and 14.8 mm., respectively (the latter of which is pictured in the upper part of the figure). Nerve-fiber and ganglion-cell deficits corresponded very closely in locus to organ of Corti damage. The curves for loss in sensitivity show that the response to all tones is impaired. As in the group with more ex-

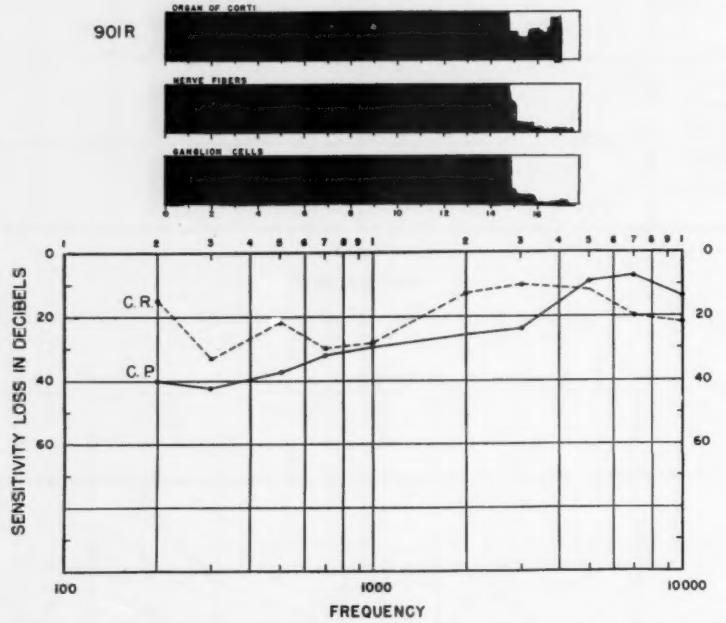

Fig. 4.—The histological picture for a typical member of the apical lesion group is in the upper part of the figure. The white space indicates injury. The scale in the horizontal dimension represents distance in millimeters in the cochlea proceeding from the basal coil. In the vertical dimension the degree of injury is represented. Below is the mean sensitivity loss for the entire group measured in two ways. C.R. stands for conditioned response data and C.P. for cochlear potential measurement.

tensive lesions, the picture gathered from measurement of cochlear potentials shows low-tone sensitivity most impaired and a gradual and progressive improvement the ioral, are presented in Figures 5 and 6. While the degree of general loss differs for the several ears, the trends seem clear and are amply represented by the curves in Figure 4.

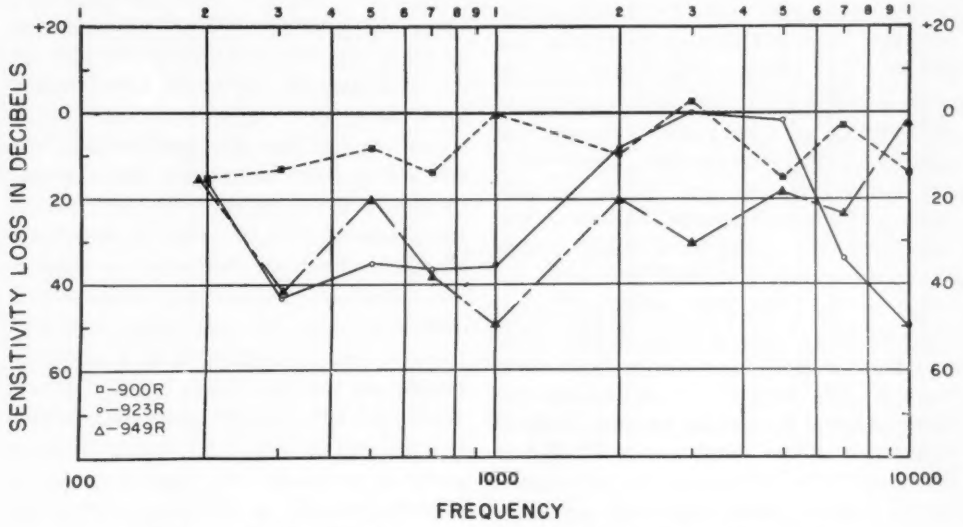

Fig. 5.—Cochlear potential loss for each animal in the apical lesion group.

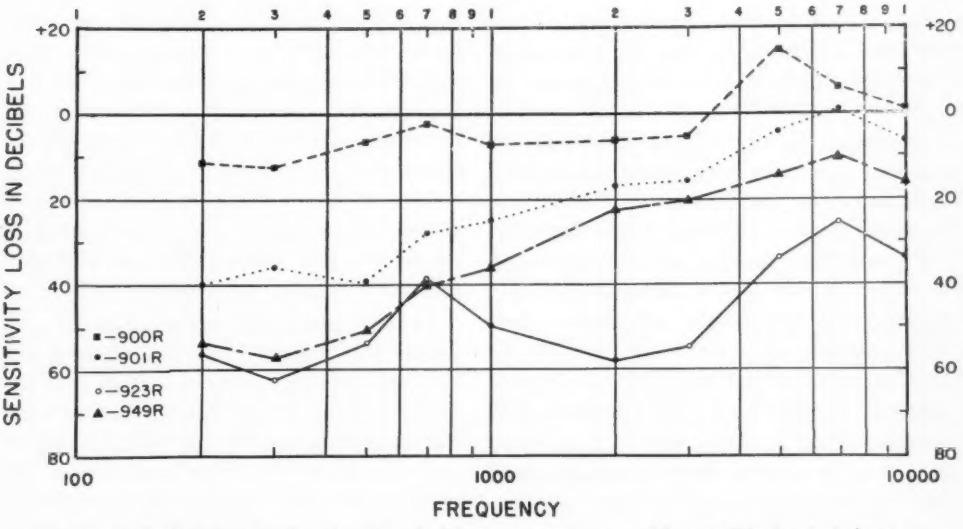

Fig. 6.—Individual hearing loss in the apical lesion group measured by conditioning techniques.

higher the tone. The behavioral picture is also consistent with the one found in the other group in that less differentiation is seen between high-tone and low-tone sensitivity. The individual-loss curves, electrical and behav-

COMMENT

We have in this experiment two independent measures of the functional condition of the ear under two separate conditions of injury involving the middle and apex of the

cochlea. When the mean curves are compared, it may be seen that the curves portraying electrophysiological sensitivity are almost identical in their characteristics, i. e., shape and magnitude of loss. This identity occurs despite the gross differences in the injuries produced in the cochlea in these two groups. The difference in the amount of gross cochlear injury for the two groups is well represented in the mean curves gathered from conditional response data. These curves are similar in shape but reflect different degrees of cochlear damage. The curve presented for the group with apical lesions shows an average loss of 20 db., while the curve for the group with middle and apical lesions shows an average of 34 db. loss. What this says, in effect, is that the conditioned-response data seem to be a better indicator of the state of the cochlea as seen histologically than is the measurement of cochlea potentials. The differences can be summed up as follows: when behavioral sensitivity is measured, injury to the apex of the cochlea results in slightly greater low-tone than high-tone loss. When both the apex and the middle portions are injured, that is, proceeding basalward, there is a further reduction in high-tone sensitivity.

The behavioral data reported here are in essential agreement with results obtained by Gross,[4] and by Schuknecht and Neff.[2] The three apical cases reported by the latter investigators show hearing loss to a wide range of tones. In only one of the cases, and this at very high frequencies, was there a lack of impairment of some other part of the hearing range. In the study by Gross, measurement of response to tones beyond 2000 cycles was rarely made. However, in every case that he reports there is a widespread loss in sensitivity, even though in many instances much of the cochlea was left intact. In one case in which the entire basal coil was uninjured the response to higher tones was measured. Even in this animal there was a loss of approximately 50 db. to a tone of 8000 cycles. There seems to be little doubt, when all the evidence is evaluated, that all tones utilize the entire cochlea for their peculiar patterns of response.

Now what implications do these results have for theories of hearing? These and most of the other findings from stimulation deafness and mechanical destruction studies have teased along investigators who hold to the idea that pitch discrimination is mediated in the cochlea. There has always been a ray of support in that high-tone sensitivity is more affected by basal lesions and that low-tone sensitivity seems slightly more impaired by apical lesions. The fact that almost always all tones throughout the range are injured, and oftentimes quite severely, seems to be a neglected datum in constructing a "place" theory of pitch perception. In most peripheral theories the cochlea is called upon to perform much finer acts of tonal discrimination than is warranted, at least from studies involving cochlear pathology. An interesting bit of evidence bearing on the issue of fine discrimination in the cochlea can be found in some of Schuknecht's data and is repeated in some of our own. It is often the case when limited apical lesions are produced that sensitivity to tones roughly up to 1000 cycles will be poor, the response to tones between approximately 1000 to 5000 cycles will be better, and the response to the highest tones, 5000 to 16000 cycles, will continue to show a downward trend. This repeated finding is certainly not in keeping with the orthodox notions of cochlear localization.

In our thinking, the very broad and general results that obtain from studies involving cochlear pathology seem to indicate that the function of the cochlea in the matter of tonal discrimination is a very broad and general one. The kind of evidence presented in this study would point to the possibility that perhaps information of a gross sort about the stimulus is being supplied by the localization patterns on the cochlea. It may provide the cue to whether the stimulus is in the high or low frequency range but hardly seems adequate as the primary mechanism of pitch discrimination.

SUMMARY

Guinea pigs were studied after mechanical injury to the middle and apical portions of the cochlea. Both behavioral and electrophysiological measurements of sensitivity loss were taken. It was found in general that sensitivity loss was apparent throughout the range of tones tested. In cases in which apical lesions were found, low-tone sensitivity was more impaired than high-tone sensitivity. When the lesions were more general, extending from the apex to the middle of the cochlea, high-tone sensitivity was much closer to that observed for the low tones. The behavioral data were found to be more closely related to the histological findings than was measurement of the electrical responses of the cochlea.

The findings are discussed with relation to the peripheral analysis of pitch. It is pointed out that these findings can support a position which attributes only gross information about pitch to localization patterns in the cochlea.

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OPERATION FOR CHRONIC FRONTAL SINUSITIS

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THE OPERATIVE treatment of chronic frontal sinusitis has given rise to much controversy among rhinologists. If one may judge from the many operations which have been devised, no single one of them is uniformly satisfactory. These operations range from the completely obliterative operation of the Riedel type at one end of the scale, to the simple drainage operation of the Howarth type at the other. Occupying the midposition we find the Killian operation and its modifications, making an effort at both obliteration and drainage. The obliterative type of operation cures the disease, but is ruled out of ordinary practice by the deformity it creates. The drainage type of operation produces no deformity, but leaves the disease still in situ, and is in fact frankly palliative, aiming at relieving the patient of his symptoms without eradicating the disease. Practically every writer on this subject emphasizes the necessity of preserving or enlarging the frontal duct, and many operators use a graft or a prosthesis in an effort to maintain its patency.

The ideal operation should combine complete obliteration of the whole sinus by bone or fibrous tissue, with complete absence of deformity.

The operation to be described here has been in use for many years and has proved so satisfactory that it is thought that it should be more widely known. It should be emphasized that it is performed only in chronic cases in which intranasal methods have failed to give relief, or in which acute exacerbations are frequent. External operations are not performed in acute cases or during an acute exacerbation, except on those rare occasions when the sinus cannot be entered through the nose and danger seems to threaten. Under these circumstances a tube is placed in the sinus through a small trephine opening, and radical surgery is postponed till the acute stage has passed. It is felt that radical operations on acutely inflamed sinuses are a frequent cause of postoperative osteomyelitis of the skull. It is true that the advent of antibiotics may change our attitude to some extent, but the general principle still holds good.

THEORETICAL CONSIDERATIONS

The theoretical basis on which this operation rests is as follows: Suppose the frontal sinus were not connected in any way with the nose but were an isolated cavity in the bone, its surgical treatment would be a relatively easy matter. It would be necessary only to remove the lining membrane completely, and healing would take place automatically, the cavity filling with granulation tissue which would ultimately become converted to fibrous tissue or bone. The main difficulty in dealing with the frontal sinus lies in its connection with the nose through the duct. This is the path along which infection originally invades the sinus, and along which reinfection may take place postoperatively. If it were possible to obliterate the frontal duct, the sinus, severed from all connection with the nasal cavities, could be dealt with as if it were a simple cyst. Obliteration of the duct and complete removal of all mucous membrane is, therefore, the principle upon which this operation rests. Although this may sound revolutionary and is certainly directly contrary to accepted teaching, nevertheless its worth has been proved by experience. If the frontal duct can be closed, the sinus can be dealt with by "enucleation" of the mucous membrane. It is obvious that every particle of membrane must be removed, so that bare bone lines the entire cavity. If any scrap of secreting surface is left behind, whether infected or not, the cavity cannot become obliterated and the operation

will fail. With the duct firmly closed and all mucous membrane stripped from the sinus, healing takes place by formation of granulation tissue, which eventually becomes fibrous tissue or bone. Once this is accomplished reinfection cannot occur.

OPERATIVE TECHNIQUE

The eyebrow is not shaved, as hair in this position takes a long time to grow. The patient is premedicated with Pantopon and scopolamine. Anesthesia is induced by thiopental sodium, and an intracheal tube is inserted. Subsequently anesthesia is maintained by nitrous oxide and oxygen supplemented by thiopental sodium or meperidine as may be judged necessary. The eyebrow is then infiltrated by procaine and epinephrine; this is a worth-while procedure to help hemostasis.

The incision is made in the eyebrow from end to end; it should be prolonged as far medially as possible without transgressing beyond the hairy part. In most cases this incision gives adequate access, but if more room is required it can be obtained either by prolonging the incision inwards by undercutting without severing the superficial layers of the skin, or by undermining the edges of the wound superficial to the periosteum and shifting the whole skin wound medially by retractors. The incision is carried down to bone through the periosteum throughout its length, and bleeding vessels are secured and ligated.

The sinus is to be opened through the roof of the orbit, so the periosteum is elevated downwards and inwards to expose the whole floor of the sinus. This should be done carefully, because if the periosteum is perforated by rough handling, periorbital fat will bulge through the perforation and may be a nuisance subsequently. It is best to start at the medial end, as the roof of the orbit arches up very abruptly laterally. Care is needed in the region of the trochlea, where the periosteum is so firmly attached that a knife may be necessary to help the elevator. The orbital contents are then drawn downward and laterally by a suitable retractor, and the sinus is opened with a small trephine through the floor at its medial part. This opening is then enlarged to give as wide an exposure as possible without encroaching on the anterior wall. Before any piece of bone is removed with the forceps, the mucous membrane of the sinus is first carefully removed from it by gauze sponging as described below, so that both bone and mucous membrane are not cut through at the same time. It is believed that one of the causes of osteomyelitis is the implantation of bacteria on damaged bone surface in this way. The floor of the sinus is completely removed, but the amount that is taken away medially and anteriorly

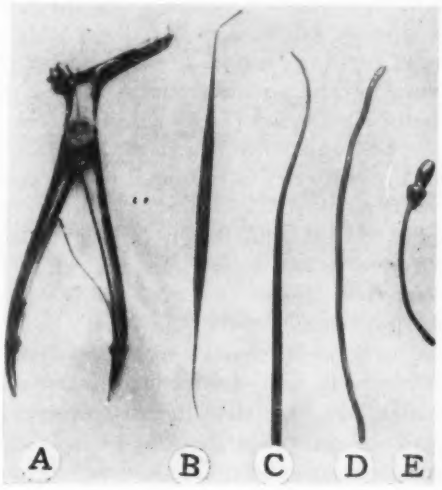


Fig. 1.—Instruments used in the operation. *A*, fine Citelli punch forceps. *B*, Jordan Lloyd probe. *C*, bendable brass probe. *D*, malleable lead probe with eye, for passing down the frontal duct. *E*, fine bendable suction nozzle.

requires judgment; removal of too little limits the exposure, removal of too much may produce postoperative deformity. Laterally where the roof of the orbit arches abruptly a small Citelli forceps (Fig. 1*A*) will be found useful.

Next follows the most important and most difficult part of the operation. The entire mucous membrane must be removed from every corner of the sinus. This is accomplished by packing strips of gauze with a probe between the membrane and the bone and so rubbing it off. Under no circumstances

is a curette or other sharp instrument (or even a blunt instrument doing the work of a curette) allowed to be used. An instrument which becomes infected and then scratches or wounds the endosteal surface of the bone is believed to be a potent cause of osteomyelitis. Naturally the danger is much greater if the sinus is the seat of an acute infection at the time of operation. The Jordan Lloyd probe (Fig. 1*B*) will be found very useful at this stage, and a semiflexible brass probe (Fig. 1*C*) which can be bent to any curve and is yet fairly strong is essential. A suction apparatus is necessary with a fine suction nozzle (Fig. 1*E*) which is soft enough to be bent to any required curve. When the sinus is approached through the floor, only a small part can be seen directly, and the removal of mucous membrane is carried out partly blindly and partly under the control of a postrhinal mirror, a supply of which is kept in hot water to be handed to the operator as required. The removal of the mucosa must be most painstakingly carried out, and every nook and cranny must be seen to be completely free of membrane. If the sinus is large with numerous septa and pockets tailing away to narrow or pointed ends, this may be exceedingly difficult and time consuming. But no matter how tedious it may be it must never be skimped as it is the key to the success; nor must the operator become impatient and resort to the curette. Sometimes in difficult situations a small piece of gauze soaked in a solution of 50% trinitrophenol (picric acid) in 35% acetone, as advised by Ferris Smith, is packed in and left for a few minutes; this seems to render the mucosa more easily removable. At this stage it may be necessary to deal with some infected anterior ethmoidal cells, if these communicate with, or protrude into, the frontal sinus. They are stripped of mucosa by the same methods. On the whole, a wide removal of ethmoids is not usually practiced, and in any case the floor of any ethmoids that are opened should be preserved and no large communication with the nose should be established, or the subsequent isolation of the sinus from the nose may be prejudiced. My experience does not support the statement that the ethmoid is the key to the frontal sinus.

When the sinus has been stripped of mucous membrane and every part has been examined carefully with the mirror to ensure that no scrap has been left behind, attention is turned to the frontal duct. A malleable probe, to which a piece of silk is attached, is passed down the frontal duct and out through the nose, and the silk is drawn after it. For this purpose the most suitable instrument is a piece of lead wire in one end of which a small eye has been cut to take the silk (Fig. 1*D*). It is easily bent and will accommodate itself to the curves necessary to pass it into the nose from a sinus which has been opened through the floor. It is easy and safe to pass this from above downward from the sinus into the nose, and one is certain that the silk passes through the true frontal duct; this is essential for the succeeding manipulation. It may be difficult to find the frontal duct if one tries to enter the sinus from below, and if a false passage is created, and the silk does not pass down the duct, the whole object of this maneuver will be defeated. A strip of gauze is now attached to the silk and is drawn down the duct and out through the nostril. Successively wider strips of gauze are now pulled through until the final strip is the widest that can be pulled through the duct when considerable force is used. Each succeeding strip is attached to the preceding one by spreading out the tail of the strip that is already in the duct and wrapping it round the leading end of the following strip. Three or four inches of overlap are allowed so that the end of the following strip is outside the nostril before its unwrapped part is gripped by the duct; when this happens the preceding strip comes away and leaves the other in the duct with an end protruding from the nose. By means of this simple maneuver the lining membrane is stripped from the frontal duct from end to end; the final forceful pulling through of the largest strip that the duct will hold ensures that this is efficiently done. It will be readily appreciated that under these circum-

stances, with no mucous membrane whatever lining the duct, its complete occlusion is inevitable.

The sinus is then loosely packed with a piece of 1 in. (2.5 cm.) gauze, the end of which is first brought out through the nose by attaching it to the tail of the last "pull-through." This gauze is sprinkled with penicillin powder. The wound is then closed by interrupted sutures, but the other end of the packing is brought out through the wound between two sutures at a convenient place near its inner end. A firm bandage is applied to control postoperative edema.

More recently the sinus has been sprinkled with penicillin powder and left without any packing at all. This may well be an improvement in technique. Alterations in what is known to be a successful method are rather unwillingly introduced, and this one has not been in use long enough for its merits to be judged.

POSTOPERATIVE TREATMENT

Morphine is given as necessary during the first 24 hours. An operation of this sort is associated with practically no shock, no matter what its length, and there is usually no rise of temperature and no postoperative pain, apart from unavoidable wound discomfort. Penicillin is given for the first week as a prophylactic measure; this is to limit infection in the sinus, as explained later, not to prevent osteomyelitis, which should not occur if proper precautions are observed. On the first day after operation the packing is withdrawn from the nose until the other end which protrudes from the wound is seen to move slightly; it is then cut off, so that a straight piece is left behind, stretching directly from the supraorbital wound, down the frontal duct, and out through the nose. On the second day this remaining piece is removed; the end which protrudes from the wound is first slightly drawn out and cut off, and the remainder is withdrawn through the nose. The stitches are removed on the fourth day. The bandage is retained for a week or so to control edema of the eye, which varies considerably from case to case, but as soon as this has subsided enough to allow the eye to be of use it is replaced by a small dressing held in place by a piece of Elastoplast. All dressings are abandoned as soon as possible. Diplopia is usual for the first day or two, but it subsides very rapidly. At no time is any cannula or other instrument passed into the sinus. No postoperative treatment of the sinus itself is carried out.

Prior to the prophylactic postoperative use of antibiotics an occasional case used to suppurate, and it was necessary to drain the sinus through the supraorbital wound. This continued for a varying length of time (sometimes a week and sometimes as long as three weeks), but eventually the discharge ceased and the wound healed. This made no difference to the ultimate result, except that when prolonged drainage through the wound was necessary the eyebrow tended to be rather fixed in position by scar tissue, and did not regain its normal mobility. Since antibiotics have been used no case has suppurated. The incidence of frank suppuration of this sort was in any case extraordinarily low, when one considers that the operation was performed on a septic cavity and that infection in the cavity after operation is inevitable in greater or less degree. It is of interest, therefore, to consider why gross postoperative infection occurred so seldom, and how a frontal sinus treated in this way heals after operation.

MODE OF HEALING

After operation we have a flask-shaped cavity whose walls are formed by bare bone except where this has been removed for access; here the wall is formed by periosteum. The neck of the flask is also bare, right down to its junction with the nasal mucosa. For the first 20 hours this is filled partly by gauze and partly by blood clot. After the first day most of the gauze is removed till only a straight strip is left from wound to nostril; most of the blood clot gets entangled in the gauze and is pulled out with it, and the cavity again fills up with fresh clot. At the end

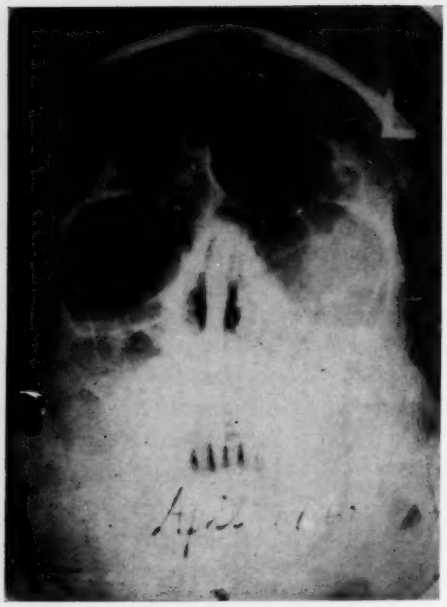


Fig. 2.—Chronic right frontal sinusitis.

of 48 hours, the last of the gauze is removed, and the sinus is left more or less completely filled with clot.

It is probable that infection in some degree is present in the frontal cavity. Of course, if it is left sterile after operation, as may happen occasionally (one sometimes finds that pus from the sinus is sterile on culture), then the blood clot becomes organized and healing takes place in a simple and straightforward manner. In the majority of cases, however, some pus must form. Now it must be remembered that, although the ultimate object of the operation is to cause closure of the frontal duct, its immediate effect is to leave it considerably enlarged by the removal of the thickened membrane that lined it. This enlarged duct will provide drainage which will be free at first, then gradually diminish, till finally it ceases altogether. If the infection in the cavity is moderate and the normal healing process can overcome it while the duct is still sufficiently open to allow adequate drainage, then healing proceeds without interruption, and the cavity behaves practically as if it had been sterile from the first. This is what usually happens. If, however, infection is severe, then the frontal duct may not be able to cope with the quantity of pus, or if infection is prolonged, the duct may close before the cavity becomes sterile. In either case the sinus will have to be drained through the wound. It is obvious that this is more likely to happen if there is an active acute infection present in the sinus at the time of operation, than if operation is performed during a quiescent period. It is here that postoperative antibiotic therapy appears to be very useful. It seems to control the degree of infection in the cavity and to limit its duration, so that the sinus becomes sterile before the duct closes. Frank suppuration entailing drainage through the wound occurred only occasionally even before the use of antibiotics, but since their routine use it has not occurred at all. Therefore routine postoperative chemotherapy would seem to be justified. It should again be emphasized that its object is to limit postoperative infection in the cavity and to ensure rapid healing, and not to

Fig. 3.—Same case as Figure 2, five years after operation. The opening of the sinus can be seen, but the sinus itself has been obliterated by bone, so that there is now no line of demarcation between the sinus and the surounding frontal bone.

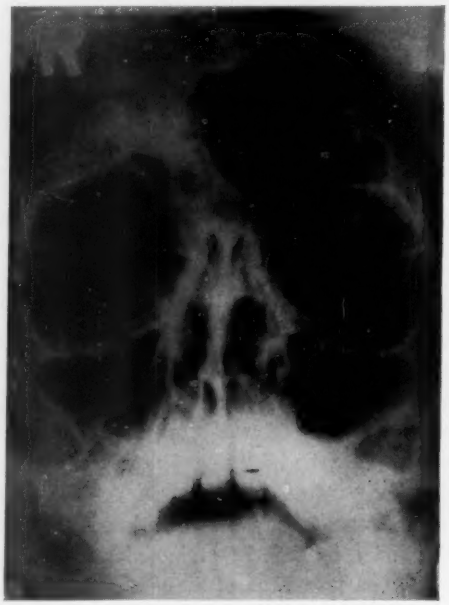


Fig. 4 (Mrs. B.).—Preoperative x-ray showing right-sided chronic frontal sinusitis.

Fig. 5 (Mrs. B).—One month after operation. The area of bone removed from the floor of the sinus can be seen. The sinus is becoming obliterated, but its outline is still visible.

prevent osteomyelitis, which should not occur if adequate precautions are taken at operation.

Once the cavity has become sterile and the frontal duct is closed, healing proceeds in an ordinary way. Granulations spring from the bone, blood clot and exudate become organized, and finally the sinus becomes filled with fibrous tissue. It is impossible for "pockets" to form, unless some piece of membrane has been left behind. If this has happened, failure is as certain as success is assured if all mem-

Fig. 6 (Mrs. B.).—Four months after operation. The opening in the floor of the sinus is quite clear. Obliteration is nearly complete, but it is still just possible to make out the line of demarcation between the sinus and the surrounding frontal bone. It is interesting to note that the right ethmoids, which were infected prior to operation, have since cleared up, without operative intervention. The antrum had previously been operated on.

brane has been removed. Frequently the cavity becomes obliterated by bone.

Figures 2 and 3 show x-ray photographs of a case before and after operation. In the second picture, taken five years after operation, the site of the opening in the floor can be clearly seen, but the sinus itself has become completely obliterated, apparently by

bone, so that it is no longer possible to distinguish any line of demarcation between the sinus and the surrounding frontal bone. It is obvious that recurrence of infection is impossible in a case such as this, for in the first place there is no frontal duct up which infection could travel from the nose, and, secondly, the frontal sinus as such has ceased to exist.

Figures 4, 5, and 6 are x-ray pictures of another case. They have been taken preoperatively, at one month, and four months after operation. The outline of the sinus is still just discernible at four months. The site of the opening in the floor can, of course, still be seen.

The cosmetic results of this operation are all that could be desired. The scar lies entirely within the limits of the eyebrow hairs and is invisible. No sinking takes place unless the removal of bone near the inner end of the supraorbital ridge has been too free, and even then only the slightest hollowness above the inner canthus can be seen. By the time healing is complete it should not be possible to tell on which side the operation has been performed.

I have never seen a case of osteomyelitis of the frontal bone following radical frontal sinus operation. This unusually low incidence must be attributed to the operative technique, and it may be instructive, therefore, to summarize the points which are believed to have been responsible for this immunity.

1. No radical operation should be performed in the presence of an acute infection, whether this is a primary acute inflammation or an acute exacerbation of a chronic infection.

2. Bone and mucous membrane are never cut together by a bone forceps. The mucous membrane is first stripped from the bone before it is cut.

3. No sharp instrument, and if possible no instrument at all, is allowed to touch the inside of the sinus. Membrane is removed by gauze strips, manipulated by a probe.

While it may be true that antibiotics have enabled us to control osteomyelitis if it develops, this is no reason for abandoning those precautions which experience has shown to be efficacious in preventing its occurrence. The probable ability to control the worst effects of postoperative sepsis does not absolve us from using every means for preventing them. It is therefore felt that these rules should be strictly followed. One must not forget that the responsible organism may be a resistant strain.

SUMMARY

An operation for the radical cure of chronic frontal sinusitis is described. It is based upon a technique which aims at complete closure of the frontal duct, and combines obliteration of the sinus with absence of deformity. It consists of complete removal of the lining membrane through the floor of the sinus, followed by stripping the mucosa from the frontal duct so as to ensure its closure. Precautions are described in detail to prevent the development of osteomyelitis. The way in which healing takes place after such an operation is discussed.

3 Fitzwilliam Place.

INTRA-ARTERIAL ADMINISTRATION OF PENICILLIN IN TREATMENT OF ACUTE MASTOIDITIS

SHIRO NAKAMURA, M.D., and KODO NAGANUMA, M.D., Tokyo, Japan

INTRODUCTION

THE PRESENT study was done in 1948, after the successful treatment of a 48-year-old patient with severe acute mastoiditis, who showed a remarkable improvement from this treatment without mastoidectomy.

The main purpose of the intra-arterial injection is the sudden attack of the pathological tissues by means of a high concentration of penicillin. The observations were clinically made on 24 patients with acute mastoiditis. Very detailed observations were carried out on 10 of these patients. In addition, 20 rabbits were used in experimentation. The observations made fall into six main categories: (1) measurements of sensitivity to penicillin of the bacteria which caused the acute otitis media; (2) measurements of the distribution of penicillin in the ear discharge and in the blood of the internal jugular vein on the diseased side following different amounts of penicillin injections; (3) comparison of the results with the use of hypertonic dextrose solution and distilled water as solvents; (4) results obtained by intra-arterial injection as compared with the results of intramuscular injection; (5) progression of phagocytosis following injection of penicillin, and (6) clinical results of this treatment.

EXPERIMENTAL PROCEDURE

The common carotid artery and the internal jugular vein on the diseased side of the patient with acute mastoiditis were surgically exposed to facilitate the injection of penicillin and the taking of blood from the jugular vein. The concentration of penicillin in the blood of the carotid artery, internal jugular vein, cubital vein, and ear discharge was simultaneously measured by means of the superimposed method[1] after the intracarotid injection of penicillin. In the experimental studies, rabbits were used, which were inoculated by repeated injections (into the tympanic cavity through the eardrum) of 0.2 cc. of hemolytic streptococci or pneumococci in bouillon taken from the patient with acute mastoiditis. The rabbits, which had already showed the manifest severe otitis media about two weeks after the first injection, were used for the experiments. Phagocytosis (in blood taken from the ear lobulus) in these patients was measured before and after injection of penicillin. The measurement of concentration of penicillin in the mucous membrane of the middle ears of the diseased rabbits following the injection of penicillin was made, using mucous membrane excised from the rabbits.

From the Department of Otolaryngology, Nihon University College of Medicine.

RESULTS AND COMMENT

1. *Measurements of Sensitivity to Penicillin of Bacteria Taken from the Ear Discharge of Patients with Acute Mastoiditis.*—The commonest bacteria which seem to cause the acute otitis media, namely, pneumococci (Types I, II, and III), hemolytic streptococci, and staphylococci, were investigated with regard to sensitivity to penicillin. The results were as follows (Table 1):

TABLE 1.—*Sensitivity of Bacteria to Penicillin*

Bacteria, Group	Penicillin, Units/Cc.
Pneumococcus	
Type I	0.02
Type II	0.02
Type III	0.02
Hemolytic Streptococcus	0.03-0.05
Staphylococcus	0.05-0.06

These results show that pneumococci Types I, II, and III are most sensitive to penicillin (bacteriostatic point of 0.2 units per cubic centimeter), streptococci is the next most sensitive (bacteriostatic point of 0.03 to 0.05 units per cubic centimeter), and staphylococci the most resistant (bacteriostatic point of 0.05 to 0.06 units per cubic centimeter). This ob-

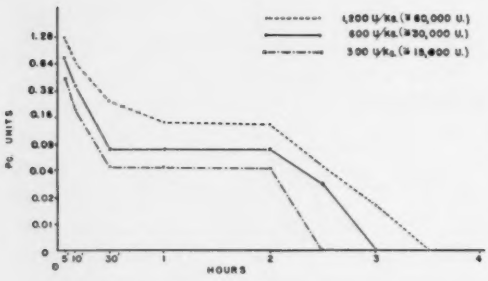
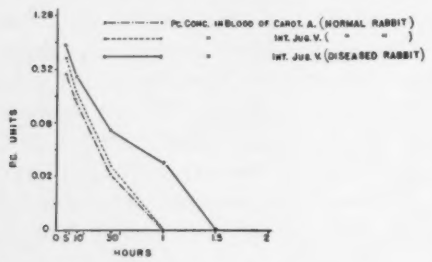


Fig. 1.—Penicillin concentration in blood of internal jugular vein in patient with acute mastoiditis following intracarotid arterial injection of 1,200, 600, and 300 units of penicillin per kilogram.

servation is in accord with the literature available on this subject. According to the experiments in vitro by Spicer and Blitz [2] in regard to Pneumococcus Type III, the ratio of the living and dead bacteria is 1 : 820,000 after being acted upon for 18 hours with 20 units per cubic centimeter of penicillin. In other words, a high concentration of penicillin has a bactericidal action. Such high concentrations of penicillin in humans, however, can not usually be obtained with long durations. It seems reasonable, therefore, that the dosage of penicillin to be injected should be determined by the sensitivity of the bacteria to penicillin. For instance, it is necessary that the concentration of penicillin in the blood always be maintained during the treatment at a minimum of 0.02 units per cubic centimeter for pneumococcic mastoiditis.

2. The Observations of the Concentration and Duration of Penicillin in the Blood of the Internal Jugular Vein on the Diseased Side

Fig. 2.—Penicillin concentration in blood of internal jugular vein and common carotid artery in normal rabbit and diseased rabbit with acute otitis media (same rabbit) following intracarotid arterial injection of 600 units of penicillin per kilogram.



Due to the Difference in the Amount of the Injected Penicillin.—Figure 1 shows penicillin concentration in the blood of the internal jugular vein as a function of time after the intracarotid arterial injection of 300 units (approximately 15,000 units in the Japanese adult), 600 units (approximately 30,000 units in the Japanese adult), and 1,200 units (approximately 60,000 units in the Japanese adult) of penicillin per kilogram, which were dissolved in distilled water. For example, in the case of the injection of 600 units (approximately 30,000 units in the Japanese adult) of penicillin per kilogram (solid line), penicillin was noted in the blood for three hours. The injection of 1,200 units (approximately 60,000 units in the Japanese adult) of penicillin per kilogram (broken line) was main-

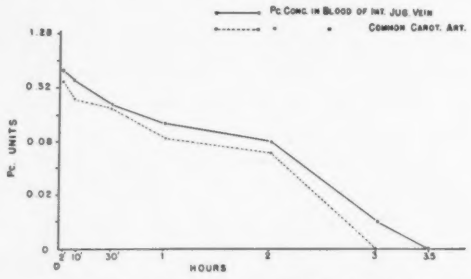


Fig. 3.—Penicillin concentration in blood of internal jugular vein and common carotid artery on diseased side of patient with acute mastoiditis following intracarotid injection of 600 units of penicillin per kilogram.

tained for three and a half hours, and the injection of 1,600 units (approximately 80,000 units in the Japanese adult) of penicillin per kilogram was maintained for four hours. (The latter curve is not shown here.) As indicated in Figure 1, a single large penicillin injection does not show as long a duration of significant concentration of penicillin in blood as might be expected.

Therefore, we conclude that an adequate dosage (without causing side-reactions) of penicillin is 600 units (approximately 30,000 units in the Japanese adult) per kilogram.

There is another interesting point to be noticed in Figure 1. These curves show that the concentration of penicillin remained nearly the same from half an hour to two hours after

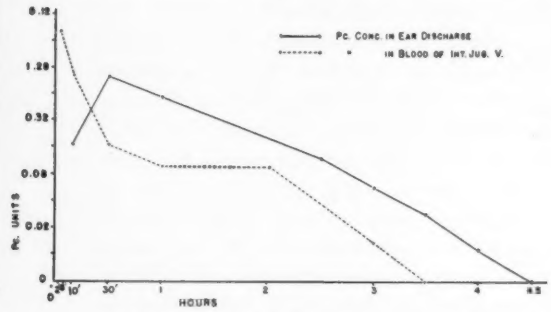
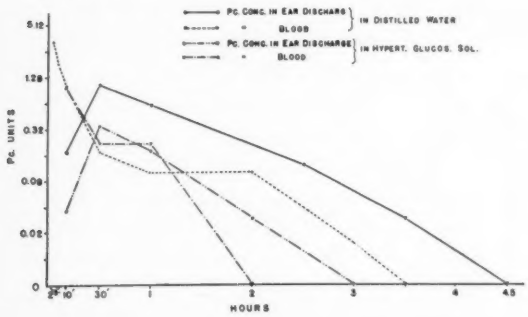


Fig. 4.—Penicillin concentration in ear discharge and blood of internal jugular vein in patient with acute mastoiditis following intracarotid arterial injection of 600 units of penicillin per kilogram (approximately 30,000 units in the adult).

injection. This tendency, however, could not be seen in normal human subjects and normal rabbits.

Figure 2 shows penicillin concentration in the blood of the internal jugular vein as a function of time after intracarotid arterial injection of penicillin in the same rabbit for two conditions: (1) normal, (2) acute otitis media. Figure 2 indicates that the penicillin concentration remained for a longer period of time in the blood of the diseased rabbit than in the blood of the normal rabbit. Figure 3 shows the distribution of penicillin in blood of the internal jugular vein and the common carotid artery on the diseased side of the patient with acute mastoiditis. The concentration of penicillin in the cubital vein is not shown here, because it is almost the same as that in the common carotid artery. Figure 3 indicates that the internal jugular vein affords greater penicillin concentration than any other vessel.

Fig. 5.—Penicillin concentration in ear discharge and blood of internal jugular vein in patient with acute mastoiditis following intracarotid arterial injection of 600 units of penicillin per kilogram dissolved in distilled water and 40% hypertonic dextrose solution.



The penicillin concentration in pathological tissues taken from the middle ears of diseased rabbits was measured after intracarotid arterial injection of penicillin. The results indicated that the duration of penicillin was greater in the pathological tissues than in the normal tissues.

Figure 4 indicates that the ear discharge of a patient with acute mastoiditis showed a greater penicillin concentration than did the blood.

It may be assumed that the penicillin concentration in the ear discharge is an indirect measure of the penicillin concentration in the pathological tissues. It would appear, therefore, that penicillin transported to the pathological tissues by means of the blood remained in the pathological tissues longer than in the normal tissues and was then reabsorbed into the blood.

3. *Measurements of the Distribution of Penicillin in the Ear Discharge and in the Blood of the Internal Jugular Vein on the Diseased Side After the Intracarotid Arterial Injection of Penicillin.*—Figure 4 shows the relationship between penicillin concentration in the ear discharge and in the blood of the internal jugular vein on the diseased side following the intracarotid arterial injection of 600 units (approximately 30,000 units in the Japanese adult) of penicillin per kilogram. As seen in Figure 4, the penicillin concentration is about three to six times higher in the ear discharge than in the blood, and lasts about one hour longer. The concentration in the ear discharge is 1.07 units per cubic centimeter at its peak at 30 minutes. In other words, penicillin in the ear discharge from the pathological tissues was always much higher in concentration and lasted longer than that in the blood. This relationship was not seen for any other injection procedures to be mentioned later.

The interval between injections of penicillin can also be determined. This is dependent upon the penicillin sensitivity of various bacteria

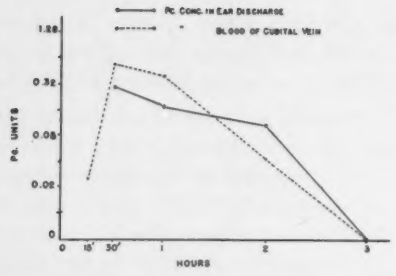


Fig. 6.—Penicillin concentration in ear discharge and blood of cubital vein in patient with acute mastoiditis following intramuscular injection of 1,000 units of penicillin per kilogram (approximately 50,000 units in the adult).

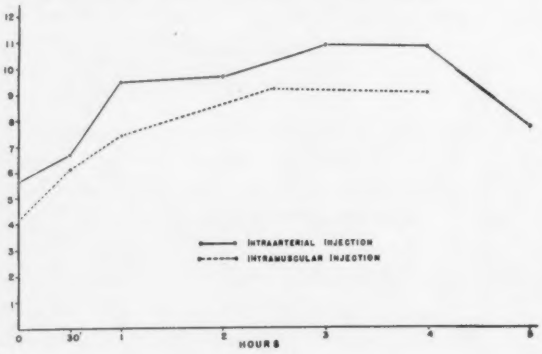
causing the acute mastoiditis. For example, if it is Pneumococcus, it would be reasonable that the interval should be every four hours. However, we have had several cases of pneumococcic mastoiditis with satisfactory results in which the interval of injection of penicillin was every six hours. It seems that these satisfactory results were obtained because of the large amounts of penicillin which were suddenly concentrated effectively upon the pathological tissues by these injections. An important point is that large amounts of penicillin remain longer in the pathological tissues with the intracarotid arterial injection procedure than with other injection procedures.

4. *A Comparison of the Results with the Use of Hypertonic Dextrose Solution and Distilled Water as Solvents.*—In order to ascertain the effects due to the difference in osmotic pressure, distilled water and 40% hypertonic dextrose solution were used as solvents of penicillin. Figure 5 shows the penicillin concentration in blood of the internal jugular vein and ear discharges of the same patient following the injection of 600 units of penicillin per kilogram dissolved in distilled water or 40% dextrose solution. Figure 5 indicates that distilled water is superior to hypertonic dextrose solution as a penicillin solvent in terms of the duration and amount of penicillin in the ear discharge. It would seem preferable to use the former, although the desirable dehydration and antiphlogistic actions of hypertonic dextrose solution have been used with good results.

5. *The Results Obtained by Intra-Arterial Injection as Compared with the Results of Intramuscular Injection.*—Measurements of penicillin concentration in the ear discharge and the blood of the cubital vein were made after the intramuscular injection of 600 units (approximately 30,000 units in a patient) to 1,000 units (approxmately 50,000 units in a patient) of penicillin. The results showed relatively large concentrations of penicillin in the ear discharge following intracarotid arterial injection but small concentrations following intramuscular injection with the same dosage of penicillin. Some patients showed no penicillin concentration in the ear discharge following intramuscular injection of 30,000 to 50,000 units of penicillin. However, in the same patients, the maximum penicillin concentrations of 1.07 units in ear discharge were noted after the intracarotid arterial injection of 30,000 units of penicillin. One exception was noted. This patient had a remarkable result following intramuscular injection of 50,000 units of penicillin (Fig. 6).

In view of these findings, it may be concluded that the penicillin concentration in the ear discharge is much lower (or nonexistent in same cases) after intramuscular injection as compared with the penicillin concentration following intracarotid arterial injection with dosages of less than 1,000 units of penicillin per kilogram. It will be remembered that persons are likely to show moderate differences in the amounts of the penicillin concentration,

Fig. 7.—Phagocytosis in patient with acute mastoiditis by both intra-arterial and intramuscular injection of 600 units of penicillin per kilogram.



both in the blood and in the ear discharge, following intramuscular injection. Following intracarotid arterial injection, on the other hand, the penicillin concentration in the ear discharge is relatively great as compared with the penicillin concentration following intramuscular injection.

6. *The Progression of Phagocytosis Following Injection of Penicillin.*—Figure 7 indicates that following both intra-arterial and intramuscular injection of penicillin in the same patients phagocytosis is increased. Not much difference is seen in the rate of phagocytosis for the two injection procedures. The progression of phagocytosis and the antibiotic action of penicillin are the means by which the disease is combated.

7. *The Clinical Results of Treatment with Intra-Arterial Injections of Penicillin.*— Table 2 shows data on 24 patients with acute mastoiditis who received treatment with intra-arterial injections of penicillin. Total amounts of penicillin which yielded satisfactory results ranged from 180,000 to 400,000 units. Three of the 24 patients did not show good results. One case showed a recurrence of mastoiditis after a temporary improvement, and the other two cases showed no response to these treatments. Twenty-one cases, or 87.5%, recovered completely. The days required for recov-

TABLE 2.—*Data on Twenty-Four Patients Who Received Treatment with Intra-Arterial Injections of Penicillin*

Patient	Age, Yr.	Sex	Bacteria, Type	Total Amount of Penicillin, Units	Result of Treatment	Duration of Treatment, Days	Note
O. D.	46	F	Pneumococci, Type III	180,000	Cured	13	.....
M. O.	23	F	Pneumococci, Type III	200,000	Cured	18	.....
I. W.	48	M	Pneumococci, Type III	180,000	Cured	18	.....
O. M.	48	F	Pneumococci, Type III	200,000	Cured	16	.....
N. I.	45	M	Pneumococci, Type III	190,000	Cured	18	.....
K. K.	70	M	Pneumococci, Type III	300,000	Cured	46	.....
H. N.	23	F	Pneumococci, Type III	400,000	Cured	53	.....
S. O.	27	M	Pneumococci, Type III	300,000	Cured	24	.....
M. M.	40	F	Diplococci	400,000	Cured	15	.....
F. K.	48	F	Diplococci	200,000	Cured	21	.....
T. K.	52	M	Diplococci	200,000	Cured	18	.....
N. M.	17	M	Hemolytic streptococci	300,000	Cured	23	.....
K. R.	42	F	Hemolytic streptococci	200,000	Cured	31	.....
S. D.	18	F	Hemolytic streptococci	200,000	Cured	15	.....
M. T.	26	M	Hemolytic streptococci	400,000	Cured	17	.....
S. T.	20	M	Nonhemolytic streptococci	300,000	Cured	14	.....
I. D.	23	M	Nonhemolytic streptococci	200,000	Cured	22	.....
H. D.	28	M	Staphylococci	200,000	Cured	31	.....
S. T.	30	M	Staphylococci	300,000	Cured	18	.....
I. O.	18	M	Staphylococci	200,000	Cured	15	.....
S. K.	40	M	.....	300,000	Cured	24	.....
I. S.	31	F	Pneumococci, Type III	300,000	Temporary improvement	19	Recurrence
Y. R.	23	M	Pneumococci, Type III	500,000	No reaction	..	Mastoidectomy
K. Y.	51	M	Pneumococci, Type III	500,000	No reaction	..	Radical mastoidectomy

TABLE 3.—*Results of Treatment of Twenty-Four Patients with Acute Mastoiditis*

Result of Treatment	Patients	
	No.	%
Cured	21	87.5
Recurrence	1	4.1
No response	2	8.3

TABLE 4.—*Distribution of Patients According to Duration of Treatment*

Duration of Treatment, Days	Patients, No.
7-14	2
15-21	11
22-28	4
29-35	2
36-53	2

ery ranged from 13 to 53. Table 3 shows the distribution according to the results of treatment of the 24 patients with acute mastoiditis. Table 4 shows the distribution according to days which were necessary for the complete improvement of mastoiditis. The time required for recovery among most of the completely cured cases (13 out of 21, or 61.9%) was less than three weeks.

CONCLUSIONS

As a consequence of these experimental and clinical studies, it would appear reasonable to draw the following conclusions:

1. The mechanism of the highly effective intra-arterial injection therapy is based on the selective action of the injected antibiotics on pathological tissues in preference to normal tissues.

2. The intra-arterial injection procedure was far more effective than the intramuscular injection procedure, particularly for cases of acute mastoiditis with Pneumococcus Type III; the intracarotid arterial injection procedure markedly reduced the frequency of mastoid operation.

3. The optimum single dosage of penicillin applied by means of intracarotid arterial injection is 600 units per kilogram, the interval between the injections being three to six hours. The duration of the interval between injections depends on the penicillin sensitivity of the bacteria which caused acute mastoiditis. The total quantity of penicillin given ranged from 180,000 to 400,000 units, depending on the severity of the disease.

4. From the clinical results showing complete improvement in 87.5% of the patients, intracarotid arterial injection of penicillin is regarded as a powerful therapeutic procedure for acute mastoiditis.

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1. Kawakami, H.: Penicillin **1**:281, 1947.

2. Spicer, S., and Blitz, D.: J. Lab. & Clin. Med. **33**:417, 1948.

Scientific Exhibits

THE TEMPORAL BONE

An Anatomic and Clinical Study

J. DUDLEY SINGLETON, M.D.; LOUIS E. ADIN Jr., M.D.; RALPH S. CLAYTON, M.D.; LEWIS WATERS, and PATRICIA O'NEILL, Dallas, Texas

THE PURPOSE of this exhibit is to demonstrate the various cell groups of the temporal bone:

I. MASTOIDOANTRAL

Squamous	Occipital
Zygomatic	Mastoid

II. PETROUS

Precarotid	Infralabyrinthine
Postcarotid	Apical
Supracarotid	Precochlear
Subtubal	

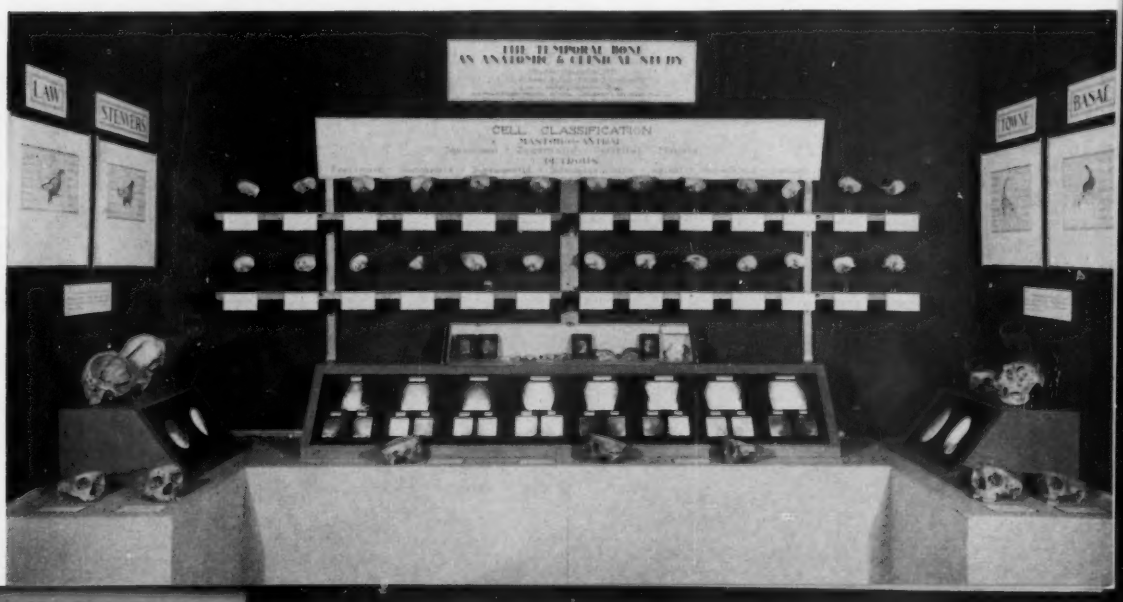
Certain specimens show unusual extension of some cell groups. Dense septa separating various groups are demonstrated.

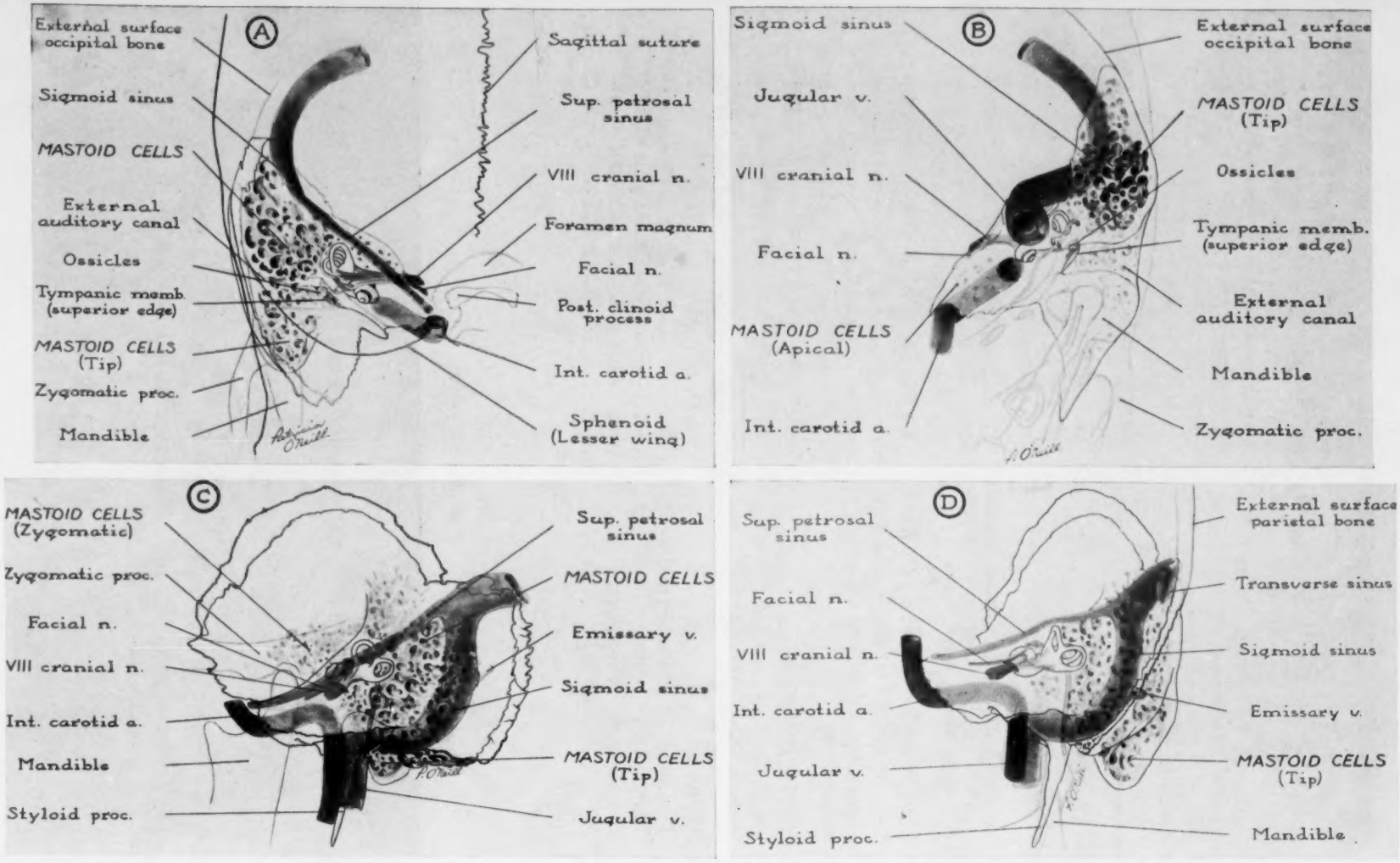
A correlation is shown between the different roentgenographic positions and the information to be derived from each, with drawings and specimens. A correlation between mastoid pneumatization and age is demonstrated by means of x-ray studies.

From the Southwestern Medical School of the University of Texas.

Shown as a scientific exhibit of the Section on Laryngology, Otology and Rhinology at the 103rd Annual Meeting of the American Medical Association, San Francisco, June 21-25, 1954.

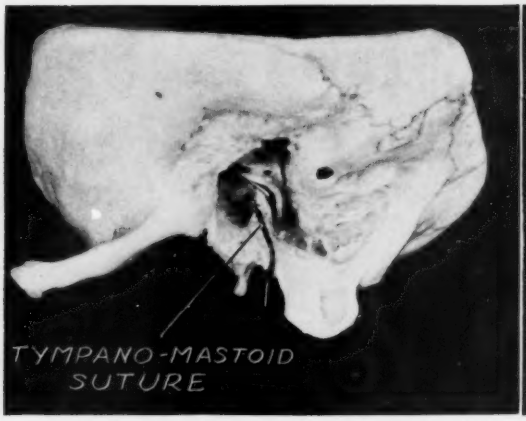
Over-all view of exhibit.





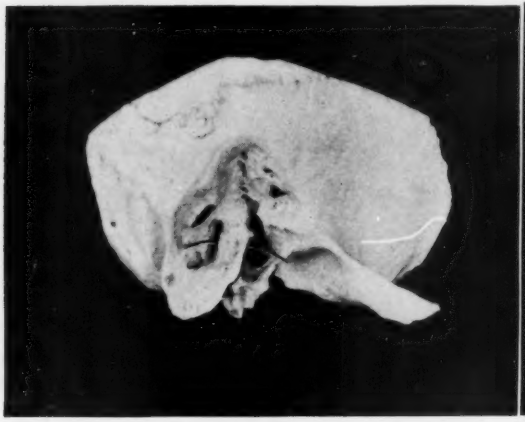
Four drawings based on standard roentgenographic positions showing the relation of mastoidoantral and petrous cells to structures within the temporal bone.

A. Towne
B. Basal
C. Law
D. Stenvers

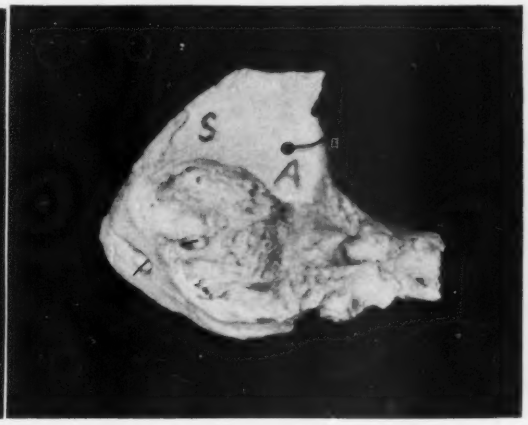


Specimen demonstrating relationship of the tympanomastoid suture to the facial nerve. A wire demonstrates the course of the nerve.

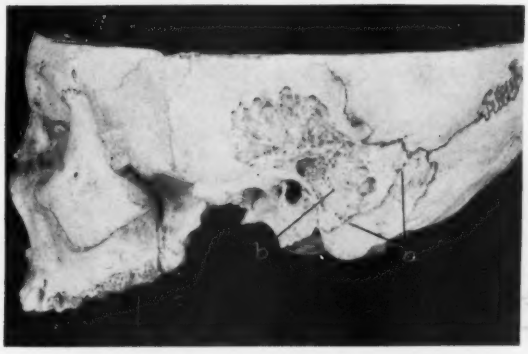
Specimen showing relationship of the outer part of the tympanomastoid suture to the facial nerve. The nerve course is depicted by a string.



Specimen showing course of a large mastoid emissary vein vulnerable at mastoidectomy.



Specimen showing a tympanomastoid tract (indicated by wire bristle) extending medial or deep to the facial nerve connecting the middle ear with the retrofacial, or "gutter," cells.

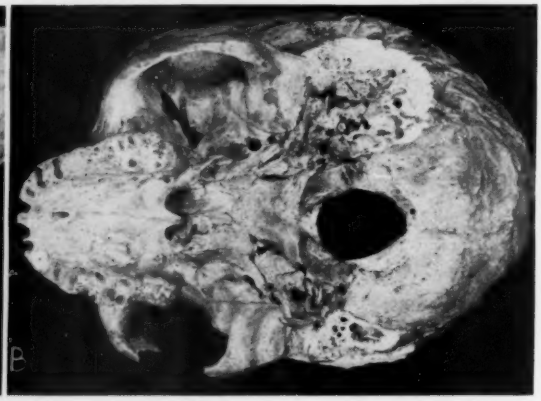


Specimen showing persistent petrosquamosal suture (*a*) on the left. Also an incomplete Koerner's septum (*b*) and extensive squamosal pneumatization.

This specimen shows squamous cells extending almost to the greater wing of the sphenoid.

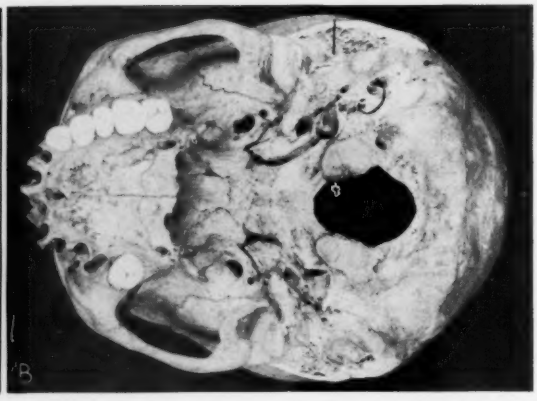
This view demonstrates the zygomatic cells.

This specimen shows on the left an unnamed septum dividing the mastoid tip cells into superficial and deep groups.



The basal surface demonstrates an extension of cells into the occipital bone on the left.

This specimen shows an unnamed septum on the left dividing the superficial tip cells from the deeper cells.



Extensions from deep cells have invaded the occipital bone.

Case Reports

COMPLICATIONS RESULTING FROM CHRONIC MASTOIDITIS WITH CHOLESTEATOMA

Report of a Case with Subperiosteal Abscess and Paralysis of the Facial and Spinal Accessory Nerves

DELMAR F. WEAVER, M.D.
DETROIT

PARALYSIS of the facial nerve resulting from chronic mastoiditis with cholesteatoma is relatively common. However, a study of the literature for the past 10 years reveals no case of either subperiosteal abscess or paralysis of the spinal accessory nerve associated with this clinical entity. For this reason it is felt that the following case report is of interest, since it includes all the complications mentioned.

Fig. 1.—Subperiosteal abscess.

Fig. 2.—Paralysis of right side of the face.

REPORT OF CASE

A 28-year-old white woman was referred to me on April 22, 1953.

She gave a history of drainage from the right ear since scarlet fever at the age of 2 years. It had been treated throughout childhood by her local physician. At the age of 10 years she was operated on for an abscess between the left lung and kidney. The operation took place in a large Eastern city, and after this the ear was treated in a clinic. Since that time there had been no pain and no conspicuous trouble until 1948, at which time complete paralysis of the right facial nerve developed. This cleared up after several months of massage and sunshine. The physician in charge at that time believed that the paralysis was not associated with the draining ear.

There had been no other operations or serious illnesses.

On March 8, 1953, she became suddenly acutely ill, with pain in the back of the neck and chills followed by a temperature elevation to 104 F. Bilateral acute cervical adenitis was present. Penicillin and oxytetracycline (Terramycin) were given, and she recovered in about two weeks.

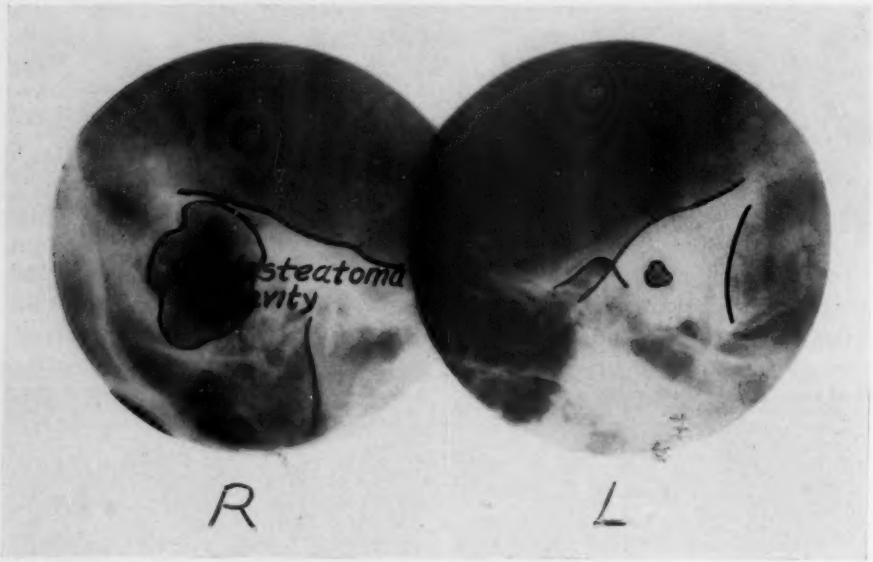


Fig. 3.—Cholesteatoma cavity in right mastoid.

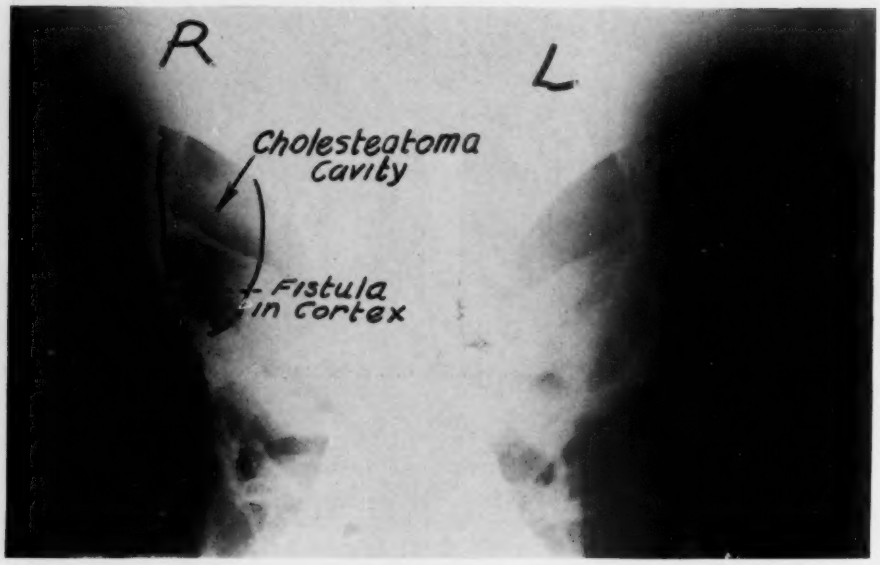


Fig. 4.—Cholesteatoma cavity; also shown is fistula in right mastoid cortex.

On March 26, 1953, complete paralysis of the right facial nerve recurred. There was severe pain in the region of the right ear. Penicillin was prescribed by a physician. About a week later marked swelling developed over the region of the right mastoid, and drainage from the ear became profuse. At that time, inability to elevate the right shoulder developed.

On examination of the ear, nose, and throat, a large abscess was noted over the right mastoid region (Fig. 1). There was profuse discharge from the right ear, and complete paralysis of the right side of the face (Fig. 2). The remainder of the ear, nose, and throat examination was negative. Roentgenograms of the mastoids showed hazing of the left mastoid. A large cholesteatoma cavity extended throughout the entire right mastoid (Figs. 3 and 4).

General physical examination revealed no significant abnormalities. Roentgenograms of the chest were negative. The blood pressure was 118 systolic and 70 diastolic, and the pulse rate was 76 beats per minute.

Examination of the blood showed a hemoglobin content of 11.5 gm. per 100 cc.; the erythrocytes numbered 4,390,000 and the leucocytes 17,250. The differential count was within normal limits. Urinalysis was normal.

On the day of admission, with the patient under general anesthesia, the skin over the right mastoid was incised, releasing 3 to 4 oz. (113 gm.) of thick pus. Culture of this later proved to be Pseudomonas aeruginosa. A fistula 6 to 8 mm. in diameter was present in the mastoid

Fig. 5.—Patient four months after operation.

cortex. On removal of the cortex a large cavity filled with cholesteatoma was found, which extended throughout the mastoid and middle ear. The radical mastoid operation was completed, and the postoperative course was normal.

Two months later there was about a 60-db. loss of hearing at all frequencies in the right ear. Hearing in the left ear was practically normal.

Four months later the radical cavity had epithelialized nicely, and movement of the face and shoulder had almost completely returned.

COMMENT

The stylomastoid foramen may lie within 2 to 3 mm. of the jugular foramen. Consequently, an infection of this extent would likely involve the structures in the jugular foramen after thorough involvement of the facial nerve.

Whether the structures associated with the spinal accessory nerve escaped involvement or it was simply less evident is not determined.

571 Fisher Building.

Progress in Otolaryngology

TUMORS OF THE NOSE AND THROAT

Summaries of the Bibliographic Material Available in the Field of Otolaryngology from February, 1951, to August, 1953

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HEAD AND NECK

FEW ORIFICES of the body exist through which signs of disease can be detected with such ease as in the case of the ears, nose, and throat. No other part of the body except the skin gives a better chance for cure of cancer. In this field, optimism in the management of cancer is warranted, according to Miller.[1] Early diagnosis provides optimal chance for cure. Five-year cures were reported in 27.5% of all cases of cancer of the paranasal sinuses seen at the Massachusetts Eye and Ear Infirmary over a 15-year period, regardless of the stage of the disease.

Cunning and Turnbull [2] estimated that cancer of the head and neck comprises 12 to 14 % of all cancers of the body. It is of paramount importance that the laryngologist's examination of these patients is not hurried and that it includes the nose, nasopharynx, pharynx, mouth, tongue, and larynx. Palpation of the tumor gives valuable information.

Martin [3] gave an excellent description of the various factors concerned in the successful performance of radical operations on the head and neck.

Royster [4] reviewed the symptoms and signs of cancer of the head and neck, with particular reference to early diagnosis and differential diagnosis. He stressed the importance of interpretation of pain in the diagnosis of lesions of the head and neck.

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Fletcher and Matzinger [5] presented cases of tumors of the head and neck in which the roentgenologic examination added information not obtainable by the usual clinical methods. The foreign radiologic literature, mainly the French, has dealt extensively with the roentgenologic diagnosis of tumors of the soft tissues of the head and neck, but the method has not met with widespread use in the United States.

Among 1,300 consecutive patients who had cancer of the nasopharynx, base of the tongue, tonsil, extrinsic larynx, or thyroid gland seen at Memorial Hospital, 163 patients stated that a lump in the neck was the first symptom, according to Martin and Romieu.[6] In only 16 (10%) of these had the nature of the primary lesion been established prior to admission. The term "lump in the neck" is invariably the phraseology used by the patient; the physician himself cannot be much more specific until he has established the actual nature of the lump. Asymmetric enlargement of one or more cervical lymph nodes in an adult is almost always cancerous and usually is due to metastasis from a primary lesion in the mouth or pharynx. Benign inflammatory hyperplasia is one of the least likely causes of such enlargement in adults. Aspiration biopsy is preferable to incisional biopsy. Under certain conditions excision of a lymph node is justifiable, specifically after repeated search for a primary lesion and aspiration biopsy have failed to establish the true histologic character of the lump. If the primary lesion is not discovered after thorough search over a period of at least two weeks, the treatment of any cervical tumor that has been proved cancerous should be complete, either by irradiation in the case of small single tumors or by radical dissection of the neck for bulky

lesions or involvement of multiple lymph nodes. All patients in whom there is a possibility of a cryptic primary carcinoma should be given frequent systematic follow-up examinations for at least five years.

Pollack [7] stated that in the physician's endeavor to enhance the survival rate of patients who have cancer it is only natural to use regularly employed methods rather than resort to procedures that have not been tested by years of clinical experience. Unfortunately, some of the more familiar methods have been far from satisfactory in the treatment of certain cancers. Thus, the clinician must continue the quest for newer procedures that may give longer survivals. Operations for the treatment of cancer of the head and neck fall into this category. The surgeon is now able to perform extensive operations that include most of the so-called inaccessible sites in the head and neck, with a negligible mortality rate. However, there is a limit to what such radical surgery can accomplish; resectability does not always mean operability. The mandible has represented a stumbling block to the ideal concept of removal in continuity of the primary tumor and the lymph nodes to which that tumor may metastasize, because of a natural reluctance to perform mutilating operations. However, the necessity of removing a portion of the mandible whenever cancer is close to the jaw should be emphasized. Beahrs and associates,[8] in a paper on combined operations for intraoral and laryngeal carcinoma, presented somewhat similar views.

Kearny [9] stated that surgical removal of malignant tumors of the paranasal sinuses, with or without postoperative irradiation, is the method of choice in selected cases. Malignant neoplasms of the tonsil are best treated by radiotherapeutists. If hypopharyngeal lesions are operable, the surgeon should handle the case from the start, but cooperative effort between the surgeon and the radiotherapeutist is necessary.

Peltier and associates,[10] in necropsy studies, found metastasis below the clavicle in 17% of 200 cases of cancer of the head and neck.

Beahrs and Jordan [11] agreed that carcinoma of the head and neck is known to remain above the level of the clavicle for long periods. Radical operation on the neck, with sacrifice of both internal jugular veins, is justified when this procedure is indicated as part of the definitive treatment of the lesion.

In each of the anatomic varieties of carcinoma of the mouth and pharynx, the reported techniques of treatment vary greatly, according to Martin.[12] Most published reports are largely limited to discussion of the primary lesions, and little consideration is given to what is actually the major problem, namely, the management of cervical metastatic lesions. Although there are many recorded cures of histologically proved cervical metastasis by irradiation therapy, nevertheless, in actual practice, dissection of the neck is generally accepted as the most effective method of treatment. The indications for dissection of the neck are the following: (1) definite clinical evidence that cancer is present in the cervical lymphatic vessels; (2) evidence that the primary lesion giving rise to the metastasis has been controlled clinically (if not controlled, there should be a plan for removal of the primary lesion when dissection of the neck is performed); (3) reasonable chance of complete removal of the cervical metastatic lesion; (4) absence of clinical or x-ray evidence of distant metastasis, and (5) evidence that dissection of the neck offers a better chance of cure than does irradiation therapy. Bilateral cervical metastasis does not constitute a contraindication to dissection of the neck.

Douglas [13] stated that blockage of neural pathways is a relatively simple procedure in lesions of the head and neck. Injections of alcohol should be made early but at a time when the pain is bad enough so that the patient will not complain about the minimal discomfort of the resultant anesthesia. Injection into the sphenopalatine ganglion of 1 to 2 cc. of 95% ethyl alcohol is extremely useful in alleviating pain of the soft palate, upper tonsillar fossa, and nasopharyngeal areas. The earache that so often accompanies

a nasopharyngeal neoplasm is usually relieved by this injection. Painful areas of the alveolar ridge, floor of the mouth, side of the tongue, and the anterior two-thirds of the tongue and gum may be rendered insensitive by injection of 1 to 2 cc. of 95% alcohol into the inferior alveolar nerve and lingual nerve. If the patient has many months of life remaining, if he is in good physical shape, and if the growth is located so as to make injections into nerves difficult or ineffectual, then neurosurgical severance should be performed. Salicylates, barbiturates, and opiates are important aids in the terminal stage, and addiction has no significance at this stage. X-ray treatments also can be employed for relief of pain.

Ewing and Foote [14] reported on 27 patients who had histologically proved plasma-cell tumors in the mouth or upper part of the air passages. The lesions were classified into three groups as follows: (1) a tumor immediately recognized as part of diffuse multiple myeloma (one-third of all the cases); (2) apparently solitary lesions confined to the soft tissues, and (3) apparently solitary lesions with evidence of local involvement of bone. Only 1 of the 27 patients was alive and free from disease after five years.

Clopton,[15] Priest,[16] and Costen[17] presented cases of plasmacytoma of the upper part of the air passages.

Havens and Lockhart [18] outlined the essential and commonly accepted opinions regarding angiomas. Methods of treatment in general are given; for specific lesions, the authors indicate those methods of treatment which have been most valuable.

NOSE

Hagens and co-workers [19] reported that under the influence of corticotropin a lesion in the nose, diagnosed as lethal granuloma, cleared up and remained healed for seven months.

From case reports published during the past 21 years there gradually emerges the picture of a peculiar syndrome consisting of a chronic ulcerating granulomatous inflammation of the nose, nasal sinuses, and, often, pharynx, larynx, and trachea, which is followed after a time by generalized periarteritis nodosa. The terminal lesion usually is of short duration, death occurring about six months after onset of nasal lesions. According to Stratton and associates,[20] the essence of this syndrome is that the lesions in the upper part of the respiratory tract are the first and, at the onset, the dominating feature of the condition. A possible relationship may exist between this disease and the condition known as "malignant granuloma of the nose."

Seltzer [21] described a man who was stabbed in the nose 20 years previously. This was followed by the development of rhinophyma and squamous-cell carcinoma, which required surgical removal of the lower part of the nose.

Congenital neoplasms of the nose are relatively rare. Macomber and Wang [22] classified them into three groups according to the origin of the developmental error as follows: (1) tumors of neurogenic origin (gliomas, encephaloceles, and neurofibromas); (2) tumors of ectodermic origin (dermoid cysts or pilonidal sinuses), and (3) tumors of mesodermic origin (hemangiomas). Glioma of the nose is a rare congenital phenomenon; only 34 cases had been recorded up to 1950. Encephaloceles contain a space lined with ependyma and filled with cerebrospinal fluid that communicates directly with the ventricles of the brain. The treatment of choice is excision of the encephalocele with closure of the dural defect. According to Macomber and Wang,[22] about 65 cases of dermoid cysts of the nose are recorded in the literature. Complete surgical excision is the only method which insures a cure. These authors stated that reconstructive operations that require removal of part of the bony structure should be postponed until growth of the nose is complete. Nasal hemangiomas are treated preferably by injection with a 5% solution of sodium morrhuate. Surgical excision is usually reserved for those which advance rapidly in size despite sclerosing therapy or those in which the diagnosis cannot be made with certainty.

Banham and Sharp [23] described an intranasal glioma in a 14-month-old infant; the tumor was successfully removed surgically.

Not more than five cases of nasal schwannoma are found in the world literature, according to Loza and Rosenzvit.[24] A case is presented in which a nasal schwannoma in a 40-year-old man arose from the region of the cribriform plate. The lesion was removed by rhinotomy.

Walker and associates [25] found a total of 34 reported cases of intranasal encephalocele. Nine patients with such lesions had associated anomalies and had died. Of the remaining 25 patients, 15 died, most of them as the result of meningitis. Of the remaining 10 patients, 5 had rhinorrhea; meningitis developed in 3 of the latter. The intranasal tumors in 13 of these 34 patients were surgically removed; 6 of the patients so treated died of meningitis, and 1 died after a secondary attempt to control the rhinorrhea by an operation through the frontal sinus. The mortality rate can be reduced to a negligible minimum if correct diagnoses are made and the cerebrospinal-fluid communications are safely repaired. This should be done through an intracranial approach. A case is presented in which severe nasal obstruction was caused by an intranasal encephalocele. Preliminary tracheotomy was necessary.

Beyer and associates [26] described an infant boy who had an intranasal meningocele successfully eradicated by intracranial ligation of the pedicle.

The literature on intranasal encephalomeningoceles was reviewed by Moore,[27] who presented one case. The diagnosis, which should be established before any operative procedure or biopsy is done, can be accomplished by observing the following points: (1) abnormal width between the eyes; (2) presence of a cystic polypoid mass in the nose, with attachment between the middle turbinate and septum or to the septum and anterior walls of the nasal cavity, and (3) presence of the lesion from birth. Roentgenologic evidence of bony cranial defects is seldom seen. Cerebral pulsations and increase in size of the lesion on crying are not seen. Intracranial repair of the bony dehiscence combined with intranasal removal of the herniated mass is advocated.

Fitz-Hugh [28] described a 5-year-old boy who had an intranasal encephalomeningocele; successful treatment was accomplished by right frontotemporal craniotomy, closure of the opening in the cribriform plate, and removal of the mass intranasally.

Finerman and Pick [29] discussed the problem of nasal encephalomeningocele. The literature is summarized, and a patient who survived intranasal extirpation is described.

Lillie [30] made a study of fluid aspirated from intranasal cysts in seven cases; appreciable amounts of sugar and chloride were present in this fluid in all seven. An impression that the presence of sugar and chloride in appreciable amounts in fluid from intranasal cysts indicates cerebrospinal fluid is incorrect if consideration is given to other properties of this fluid.

Proper knowledge of the anatomic characteristics of dermoid cysts of the nose is essential before any curative procedure is undertaken, according to Champion and Prendiville.[31] The authors offer an explanation of the origin of such cysts based on studies of cross sections of the nasal cartilage in the newborn infant. Treatment consists of complete excision of the sinus and cyst. The authors present a surgical procedure to accomplish this.

Crawford and Webster [32] expressed the belief that the majority of dermoid cysts of the nose of the congenital inclusion type are rather simple in nature and that their surgical treatment presents no major problem. However, a few of these cysts are more complex. A series of 14 cases of dermoid cysts of the nose is presented, with 4 of the more complicated cases described in detail. The injection of methylene blue into the sinus tracts previous to operation helps to determine the location and extent of these tracts.

A great variety of cysts on and around the nose are related to developmental processes and must be differentiated from each other as well as from other types of cysts. Klestadt [33] considered that the theory of

these cysts arising on the basis of facial clefts better explains the origin of cysts originating in the nasoalveolar region than does the theory of retention cysts.

Primary benign nasal tumors are rare as compared with malignant ones. A series seen by one surgeon usually does not include all the known types and is too small to serve as a basis for conclusions. Handousa [34] has seen 73 benign tumors of the nose, including 35 osteomas, 22 hemangiomas, 11 fibromas, 2 papillomas, 1 chondroma, 1 lymphoma, and 1 myxoma.

Saxen,[35] on histologic grounds, divided papillomas of the nose into benign and malignant groups. The epithelium of benign papillomas shows only slight variations in the size of the nuclei and nucleoli, and few mitotic figures. In malignant papillomas, the nuclei and nucleoli are markedly polymorphic and numerous mitotic figures are seen. The corresponding variations in the epithelium of papillary carcinoma are greater still. He has not seen a single case in which carcinoma developed from a nasal polyp. However, some papillomas undergo malignant transformation; he has seen one of this kind.

Papillomas are fibroepithelial tumors consisting of a more or less abundantly ramified stroma covered with epithelium. Twenty-one cases of nasal papilloma were reported by Hendriksson.[36] All but one were unilateral. They have a great tendency to recur; they are destructive, but the symptoms are meager. Nasal obstruction accompanied by rhinitis usually leads persons who have such lesions to seek medical attention.

Papillary sinusitis appears in the literature under various appellations, such as epithelial polyp, epithelial papilloma, diffuse or soft nasal papilloma, and fibroepithelial polyp. The condition is rare. In routine examination of surgical specimens of sinus mucous membrane, Judge [37] encountered papillary sinusitis in 9 of 1,200 specimens. Most writers stress the tendency of the condition to recur and its precancerous nature.

Ormerod [38] made a preliminary report of 29 cases of cylindrical-cell carcinoma of the nose, which apparently arises in nasal polyps. The history is usually that of unilateral nasal obstruction over a long period and may include repeated removal of polyps and operations on the sinuses. Bilateral obstruction is rare. The affected side is filled with a polypoid mass that varies from the typical semitranslucent grape-like structure to a solid fleshy mass, which differs in consistency from an ordinary polyp and suggests neoplastic change. The mass rarely, if ever, becomes a pedunculated nasopharyngeal polyp. It is difficult to be certain where the origin may have been, although the middle meatus of the nose appears to be the most usual site. The sinuses were involved to a varying degree in this group of cases, being completely unaffected in six. The microscopic appearance suggests that metaplasia has taken place in an otherwise normal polyp. However, their great tendency to be unilateral, in spite of being present for as long as 13 years, is unusual in common inflammatory polyps. Ormerod stated that the term "papilloma" should not be applied to these growths, as their mode of formation and their structure are different from those of papillomas; moreover, its use is misleading, as it implies a stage in the development of these growths when they are innocent, and it is not certain that this is true. He concluded that there is a change in the epithelium of these lesions which in some cases proceeds rapidly and in others much more slowly, but relentlessly, to a malignant condition. Localized areas are found in which active signs of malignant change, such as mitotic figures and small areas of squamous metaplasia, can be seen; thus, it appears that the carcinoma is multicentric. These areas resemble carcinoma in situ.

A case of papillary adenocarcinoma of the nasal cavity containing argentaffin cells and producing distant metastasis was reported by Simard and Jean.[39]

Polyps containing cerebral tissue were found by Cruickshank [40] in the upper portion of the nasal passages, at necropsy, of a woman who had died of a meningioma. These polyps probably resulted from herniation of

cerebral tissue through the foramina of the cribriform plate of the ethmoid, due to increased intracranial pressure. The relatively large nasal polyps present in this woman almost certainly would have been found during life if the nasal passages had been examined by a rhinologist; their histologic structure would have been extremely puzzling had they been received as surgical specimens.

Gabriel [41] reported the second case of a mixed tumor of the nasal septum to appear in the literature. A sublabial incision (extended Denker) provided ideal access to the lesion.

Chondroma and chondrosarcoma rarely involve paranasal sinuses and intranasal structures. The intricate anatomic structure of the parts involved usually precludes complete eradication in the sense of removal with a safe margin. Results of irradiation are disappointing. A new case was presented and another reviewed by Lawson [42] to illustrate the different pattern of behavior likely to be encountered in intranasal chondrosarcomas at opposite ends of the life span. Rhinologists must weigh the problem of recurrence after palliative treatment against the problem of functionally and cosmetically undesirable results of attempts at complete eradication.

Malignant melanoma of the nasal chamber is considered to be rare, but Stewart [43] stated that this lesion constitutes a far from negligible proportion of cases of malignant disease of the nose. He found reports of 77 cases in the literature and studied 15 such cases seen at his hospital. Except in the few cases in which pigment is visible in the tumor, clinical examination can only lead the physician to suspect the presence of a melanoma. In two of Stewart's patients, black, purple, or brown pigment was present in the tumor; in four patients, pigment was noted in the mucous membrane adjacent to the tumor. The tumors in Stewart's series apparently originated most frequently in the anterior and lower part of the nasal chamber, not far behind the mucocutaneous junction (six patients). Only one lesion was limited to the posterior part of the nose. The other tumors were too extensive to allow definition of their starting point. No external abnormality other than bulging of the nostril was present in 12 patients. Epistaxis was frequent but pain was not. Eradication of the tumor was attempted in 13 of these 15 patients. Ten patients were dead and five were living (all less than two years) when this report was made; recurrence was present in two of the latter. The first treatment for nasal malignant melanoma should be wide surgical excision. Spread to local lymph nodes is late and distant metastasis even later; possibly half the patients came at a stage when the macroscopic primary tumor could have been excised.

Sirsat [44] stated that the lining of the upper portion of the nasal cavity and the epithelium of the olfactory mucosa contain considerable amounts of granular pigment. Therefore, it might be thought that they are more favorable sites for melanomas than the lower, pigment-free portions. However, this is not the case, for these tumors arise in the pigment-free mucosa, including that over the turbinate bones. He stated that the diagnosis of malignant melanoma in the nasal and paranasal regions should not be considered established unless tumor cells containing pigment proved to be melanin are identified. Recurrent lesions may not contain any pigment.

Morey [45] presented a case of malignant melanoma occurring on the inferior turbinate.

A case of osteogenic sarcoma metastatic to the nasal mucosa of the left inferior turbinate was reported by Judge.[46] Although they are extremely rare, metastatic lesions should be considered in the differential diagnosis of tumors of the nose.

Tamari and Weisman [47] reported an unusually large benign osteoma of the ethmoid sinus that had not caused any symptoms in its intracranial or intranasal ramifications.

Dintenfass and associates [48] discussed an ossifying fibroma of the ethmoid sinus in a 25-year-old woman, who had noted symptoms since the age of 13 years. It was successfully removed by an external approach.

Fineberg [49] considered that osteoma of the outer wall of the frontal bone can be removed by the endonasal plastic approach.

Tolczynsky [50] reported an epidermoid carcinoma of the right ethmoid labyrinth with polypoid features. The article includes a review of the literature, with a discussion of the pathology and treatment.

Two cases of lymphosarcoma of the ethmoid were presented by Harrison.[51]

Tumors arising from the mucosa of the frontal sinus occur less frequently than tumors of the ethmoid and maxillary sinuses, according to Brunner.[52] Two factors may help to explain the difference: the frontal sinus is absent in 5 to 10% of normal adults and tumors of the frontal sinus cause nasal symptoms much later than do tumors of the ethmoid or the maxillary sinuses. A small hemangioma of the frontal bone apparently arising from the diploic veins and an osteogenic sarcoma arising from the periosteum of the frontal squama were reported.

Six cases of osteoma of the frontal sinus were presented by Colver.[53]

Corbett [54] reported a case of ossifying fibroma of the frontal sinus.

Norton and Wood [55] described a patient who exhibited a clinical picture superficially resembling mucocele of the frontal sinus. Erosion of the orbital roof, erosion and expansion of the labial wall of the frontal sinus, and the absence of continuity between sinus and cavity suggested an expanding lesion in the frontal bone. The cause of this lesion is obscure; it may be described as a hemorrhagic cyst or pseudocyst of the frontal bone. The wall of this cyst consisted of granulation tissue and collagenous fibrous tissue, within which were large areas of cholesterol deposition, lymphocytes, eosinophiles, hemosiderin-containing phagocytes, and an occasional giant cell of the foreign-body type. These hemorrhagic cysts may represent eosinophilic granuloma in a late phase of degeneration.

Holmes and co-workers [56] presented three cases of hemangioma of the frontal bone, a condition which appears to be extremely rare. Diagnosis can be made roentgenologically.

Wilmot [57] reported a case of squamous-cell carcinoma of the frontal sinus in a 57-year-old woman.

ANTRUM

The usefulness of cytologic examination as a diagnostic aid in malignant tumors of the maxillary sinus was demonstrated in a report of four cases by Armstrong.[58] In each instance, roentgenograms of the sinuses indicated a pathologic condition in the antrum, even to the point of osteocytic changes; nevertheless, two lesions were interpreted by the roentgenologist as instances of chronic maxillary sinusitis. In all four cases, the diagnosis of malignant tumor was first established by cytologic examinations of antral washings and confirmed later by biopsy.

Salinger [59] reviewed the available literature on the paranasal sinuses and included reports dealing with tumors of this region.

At present the most effective treatment for carcinoma of the paranasal sinuses consists of a combination of radiation and surgical intervention, according to Schuknecht.[60] However, some disagreement exists as to how these agents should be used together. It is known that radiation lethal to cancer is followed frequently by sepsis and sequestration and that wide surgical exposure and drainage are necessary. Thus, because some form of operation is required eventually after radiation therapy, it appears logical that operation should be done in the beginning and should be a vigorous attempt at complete removal of the neoplasm. If this is followed by cancericidal doses of radiation, the patient has received the best treatment. There are several contraindications to the definitive surgical removal of a primary malignant lesion of the paranasal sinuses. 1. Complete resection is impossible when there is invasion of the base of the skull. 2. If the neoplasm is adherent to the walls of the nasopharynx, it probably cannot be resected. 3. Operation is to be avoided if there is extensive bilateral involvement, because of the hopeless facial defects which result. 4. Distant visceral or skeletal metastasis almost certainly precludes a cure, and complete resection of the primary lesion should not be attempted. 5. The same

holds true in the presence of insurmountable regional lymphatic metastasis. About 30% of all patients who have carcinoma of the paranasal sinuses fall into an inoperable group.

There is an excellent description of the surgical technique in performing classic block resection of the maxilla and various modifications of this.

Moffet [61] stated that malignant tumors in the upper jaw, the nose, and nasal sinuses show a variety of pathologic appearances that seldom can be equaled in other parts of the body. The tumors divide themselves into lower and upper groups. Tumors of the lower group appear to take origin from within the alveolus of the upper jaw. Extensive growths are often symptomless until the whole of the jaw has been infiltrated or the antrum filled with a mass of malignant tissue. Tumors of the upper group originate from approximately the same areas as the nasal sinuses. It is generally accepted that the treatment of tumors in the lower group is hopeful, while the treatment of tumors in the upper group is not. Because the eye presents an extremely awkward obstacle to irradiation or surgical excision, it will be seen that any difference in the general nature of the growth is by no means the main factor in unsuccessful treatment of tumors of the upper group. The principles of treatment are to excise and destroy; this means an attempt at complete excision of the growth followed by maximal irradiation. The nature of the condition is carefully explained to the patient, and the severity of the operation and the discomfort of the after-treatment are in no way minimized. Little is the likelihood of success with small incisions intended to spare the patient some minor discomfort or facial blemish. No set operation can be employed for the removal of the tumor, and only occasionally can one carry out the textbook operation of excision of the upper jaw. Prolonged painstaking work by the dental surgeon is in many respects the most important feature of rehabilitation of the patient, and disfigurement after operation is remarkably slight. Complete removal or destruction of the growth is the only hope of survival. Neither operation nor irradiation alone can achieve this end in every case. Combined, their chances of producing success are multiplied. They are not rival but complementary methods of treatment.

Davis [62] used a modified Ferguson incision to allow thorough exposure of the neoplasm in the nose; he prefers radical electrosurgery by means of diathermy.

Kaikini [63] recommended early surgical removal of the maxilla in the treatment of malignant tumors of the upper jaw; the operation should be done with the aid of local anesthesia, because shock is practically nil. Even in advanced stages of maxillary malignant lesions, in which the maxilla was excised and the patient died of recurrence later on, life was rendered more happy by the disappearance or pronounced alleviation of pain.

Surgical intervention, including electrosurgical techniques, constitutes the basic treatment of expanding tumors of the maxillary sinus, according to Heatly.[64] It must be combined with intensive irradiation when the tumor is malignant. Even in highly anaplastic tumors, operation may prove of value by providing drainage of associated suppuration as well as adequate exposure for implantation of radium. The external approach offers an unexcelled view of all portions of the antrum as well as the adjacent nasal passage. The optimal method of surgical approach will, of course, depend on the clinical as well as the roentgenographic findings. Lateral rhinotomy offers many advantages in the management of these expanding growths.

Weaver [65] expressed the belief that apparently little more can be done to facilitate earlier diagnosis of malignant tumors with present methods. He stressed the value of grading tumors and the superiority of electrosurgery.

Hughes and Archer [66] described a method of constructing radium applicators for the irradiation of markedly irregular cavities in the antrum and mastoid resulting from operation.

Erich [67] presented a classification of various tumors of the jaws. This classification is helpful in diagnosis and treatment.

Girdwood * stated that osteofibroma of the maxilla should not be treated by radical resection because the patients are young children or young adults and because these growths do not become malignant. Shaving down the excessive prominence on occasions allows the general features to be preserved. After the patient attains adulthood, these growths do not progress further, and a final trimming to the natural state is all that is required.

Wass [70] stated that treatment of simple tumors of the upper jaw demands surgical judgment rather than technical skill. Diffuse fibrous dysplasia involving the entirety of the upper jaw occurs most commonly in patients less than 20 years of age. It is impossible to remove these extensive tumors completely, and simple "paring down" of the overgrown bone is all that is necessary. X-ray therapy never should be used.

Smith and Zavaleta [71] quoted Lichtenstein, who said that the term "osteoma" is much abused. The all-inclusive use of the term encompasses any growth with a histologic appearance of bone occurring in an unusual site or that is representative of unusual osseous growth. Its specific use is confined to osteomas of the facial or cranial bones, namely, certain bony growths that arise particularly in bones of the skull preformed in membrane and that are prone to extend into the orbit or into one or another of the paranasal sinuses. Arguments are given in support of the consideration of osteoma and ossifying fibroma (monostotic fibrous dysplasia) of cranial and facial bones in the same clinical and pathogenic group, as opposed to their complete separation and as opposed to the identification of ossifying fibroma as only a form of fibrous dysplasia.

Knowledge of the terminology, nosology, and embryology of tooth structure is essential for the understanding of odontogenic tumors and cysts. This basic information has been reviewed by Heck,[72] who correlated it with the formation, diagnosis, and treatment of such tumors and cysts. The individual anlagen are tabulated, treatment is discussed, and the need for radical operation for cure of adamantinomas is stressed. A case report of adamantinoma of the maxilla in a 4-year-old boy illustrates this type of management.

Lucas [73] presented an account of those lesions of the jaws in which epithelial proliferation may occur. It includes a brief description of the various cysts of dental origin and of the malignant tumors that might occur, especially adamantinomas.

Handousa [74] saw 12 cases of giant-cell tumor of bone in the nasal region. The tumor was always single, was well localized in spite of its large size, and was benign. This tumor is encapsulated and is, as a rule, pale brown or grayish. Maxillary giant-cell tumors have a roentgenologic appearance similar to that presented by a bone cyst. He prefers excision rather than irradiation.

Handousa [75] also presented 14 consecutive cases of adamantinomas of the superior maxilla; 9 were solid and 5 were cystic. The age incidence varied between 20 and 40 years; 11 patients were men. Only 2 of these 14 lesions gave the accepted characteristic roentgenologic picture of adamantinoma. All were eradicated surgically; no recurrence had occurred at the time the report was made.

Cylindromas are malignant tumors occurring wherever salivary or mucous glands are found. Billroth first used the term "cylindroma," in 1856, to describe a tumor that had arisen from the mucous glands of the accessory nasal sinuses. He referred to a tumor composed of glossy translucent cylinders of hyaline connective tissue, between which ran a network of tumor cells. Sometimes it is called simply a "mixed tumor" and classified as benign. The insidious malignant nature of this tumor is not recognized by many clinicians, according to Pollack.[76] The persistent and relentless nature of recurrences over a period of years suggests a guarded prognosis for all patients who have this type of tumor, and suggests more radical initial treatment.

A rhabdomyosarcoma originating in the maxillary sinus in a 12-year-old boy was re-

* References 68 and 69.

ported by McCuaig.[77] The literature contains only rare reports of such tumors in the field of otolaryngology. However, many tumors designated as round-cell and spindle-cell sarcoma in reality may be rhabdomyosarcomas. Thorough surgical removal of the tumor followed by x-ray or radium therapy has been the treatment of choice.

High [78] reported two cases of sarcoma of the nose and sinuses. The first case was unusual because a chondrosarcoma apparently developed within a mucocele. The lesion in the second case was a primary chondrosarcoma of the nasal septum, which has not been reported previously.

Bagley and Smith [79] stated that meningiomas of the sphenoid ridge may erode through the floor of the middle cranial fossa into the zygomatic fossa or the antrum or both. The extracranial signs of unilateral, painful, nonpulsating temporal fullness and unilateral nonpulsating proptosis, occurring in a middle-aged person, always should suggest the possibility of a lesion of intracranial origin; the most likely lesion is a meningioma of the sphenoid ridge. The diagnosis is most certain when supported by roentgenologic evidence of hyperostosis or erosion of the sphenoid ridge, supraorbital plate, or squamous portion of the temporal bone.

NASOPHARYNX

Rubenfeld and Winston [80] described a simple suction technique employing a cannula that may be useful in searching for cryptic tumors in the nasopharynx. Its simplicity makes it useful (1) when a specimen for biopsy is unobtainable, owing to the size of the growth; (2) when a patient refuses consent for biopsy; (3) in the presence of palpable lymph nodes when biopsy shows no conclusive evidence of tumor; (4) to follow the effects of treatment, and (5) to establish the presence of recurrence after treatment. Two instances of malignant tumors whose presence was noted in aspirated cells are briefly presented.

Geist and Portmann [81] reviewed malignant tumors of the nasopharynx, based on observations in 72 consecutive cases seen at the Cleveland Clinic. The over-all five-year survival rate was 10%.

Two lessons have been learned from a long experience with malignant tumors of the nasopharynx by Digby [82] in China and Hong Kong, where the disease is rife. The first principle of treatment is that early diagnosis is essential. The second principle is that radiotherapy is the weapon of choice in fighting this disease.

Nasopharyngeal malignant tumors responded badly in the past to any form of treatment, but the prognosis is now much better, owing to recent improvements in the technique of radiotherapy, according to Ormerod.[83] Of all the patients suffering from malignant disease seen in an ear, nose, and throat clinic, 8% have malignant lesions in the nasopharynx, and about a fourth of these patients are women. The signs and symptoms of malignant disease of the nasopharynx may be divided into four main groups, namely, nasopharyngeal, otologic, ophthalmoneurologic, and cervical metastatic.

Two major types of nasopharyngeal growths are seen; one originates in the nasopharynx, whereas the other is an extension from the base of the skull and appears secondarily in the nasopharynx. A review by Daito and co-workers [84] covered 68 cases of nasopharyngeal tumors reported in the Japanese medical literature. Intracranial involvement was present in 52.9%. Whenever accessible, surgical extirpation of the growth after Hoshino's technique was followed. This consists of splitting the soft palate, which permits an easier inspection of the growth and a direct approach to the site of the neoplasm. This was followed by implantation of radium and x-ray therapy. In inoperable cases, only radium and x-ray treatments were given.

Thompson [85] presented four cases of lymphoepithelioma of the nasopharynx. A general review of the literature is offered, with special emphasis on the pathology and diagnosis of these comparatively infrequent neoplasms of the nasopharynx.

Vincent [86] reported a neuroblastoma of the nasopharynx that probably commenced in the neck in the cervical sympathetic tissues.

Larsson [87] described microscopically verified changes in the nasopharynx in 10 cases of generalized sarcoidosis. In the majority of cases these changes consisted of circumscribed reddish-yellow lobulated zones of infiltration, confined to the median line of the posterior nasopharyngeal wall at the site of the lymphadenoid tissue. In a few cases the lesions were so large that they were clinically similar to malignant tumors; in some instances, they caused discomfort. In all cases, rapid subjective improvement and definite clinical regression of the nasopharyngeal lesions occurred after roentgen therapy.

The diagnosis and treatment of malignant lesions of the nose and throat all too frequently can be summarized as "too late and too little." Sooy [88] gave a brief outline of such tumors and summarized the commoner methods of treatment. In a few patients who had recurrence of carcinoma of the nasopharynx after the usual methods of treatment, he performed intranasal resection of the entire posterior three-fourths of the cartilaginous and bony septum with the patient under general anesthesia. The local tumor was extensively cauterized with a special Bovie applicator. Radioactive cobalt was then applied in an amount of 3,000 to 6,000 roentgen equivalents. If palpable cervical lymph nodes were present, radical dissection of the neck was carried out. This experimental radiosurgical treatment in the nasopharynx is presented for the first time in this report.

Wilson [89] described an approach to the nasopharynx that consists of a transverse incision between the hard and soft palate; the entire soft palate is then pushed backward, and the incisions are extended downward to the outer side of the tonsillar fossae. The incision may be extended into the pterygomandibular raphe.

Heck and McNaught [90] presented a transpalatal approach that was used in two cases for removal of juvenile fibroma of the nasopharynx. Exposure of the operative field was adequate, and the tumors apparently were excised successfully.

Penha [91] administered an extract of the nettle Urtica membranacea to a boy who had juvenile nasopharyngeal fibroma. The patient also received x-ray treatments. The fibroma subsided.

Radcliffe [92] reported successful transantral removal of a fibroangioma in a 16-year-old boy.

Finerman [93] presented a case of juvenile nasopharyngeal angiofibroma in a girl. The appearance and location of the tumor, as well as biopsy, supported the diagnosis. The occurrence of such tumors in females has been challenged. No history of epistaxis or hemoptysis was obtained, nor did the taking of a specimen for biopsy cause undue bleeding.

Dahlin and MacCarty [94] made a study of 59 chordomas. Fifteen were found in the clivus at the base of the skull and nine in the cervical area. With rare exceptions, chordomas arising in the spheno-occipital area have a hopeless prognosis.

Sennett [95] reviewed the roentgenologic findings in 11 cases of chordoma and evaluated the results of roentgen therapy. The outstanding roentgenologic diagnostic features were (1) an irregular lytic destruction of the involved vertebral bodies; (2) preservation of the disk spaces despite destruction of the bone, and (3) a soft-tissue mass compressing an adjacent organ or protruding into the spinal canal. Irradiation is useful as a palliative measure only in cases in which complete removal of the tumor has been impossible.

Chordomas are rare tumors found along the spinal column; they arise from remnants of the notochord. These remnants are present as the soft central core of the intervertebral disks, according to Mancoll and Snelling.[96] The average age of the patients is 60 years. Chordomas are benign as a rule, yet about 11% are known to metastasize. They are slow-growing tumors and are encapsulated and vascular. Chordomas in the cervical region invade the roots of the cervical nerves and cause pain and stiffness of the neck.

When they point anteriorly into the pharynx and attain a sufficient size, they interfere with swallowing. The diagnosis must be made from biopsy, and the treatment is surgical. The location of the tumor makes the approach difficult. Furthermore, the tumors, by the time they have produced symptoms, have attained such size that it is almost impossible to remove them entirely; hence, repeated surgical procedures are the rule.

EAR

Carcinoma arising in the external ear gives the physician the advantages of observation, detection, and a chance of cure rarely present in malignant lesions in other areas of the body. In spite of such obviousness, deaths still result from neglect, inadequate management, or from the rare uncontrollable highly malignant lesion. Not more than 5% of all epidermoid carcinomas of the face and neck metastasize. The all-too-frequent necessity of mutilation by operation late in the course of the disease bespeaks inadequate early treatment. New growths and the presence of chronic discharge from the aural canal should be considered as evidence of malignancy until proved otherwise. Early lesions can be treated adequately by x-rays, radium, or surgery. Surgical removal offers many advantages. The surgical approach to carcinoma of the ear calls for wide excision of the tumor. Compromise of the principles of radical removal, usually made because of surgical timidity for cosmetic reasons, often spells doom for the patient. Preservation of the facial nerve should not be considered in radical extirpation for cancer. Prophylactic dissection of the neck for carcinoma of the pinna or external auditory canal is not recommended because of the low incidence of metastasis. Large ulcerated lesions, perichondritis, and recurrent lesions after inadequate operations or roentgen therapy usually require extensive destructive surgical intervention. Because of the tendency for recurrence even after extensive surgical removal, cautery, and roentgen therapy, Robinson and associates [97] stated that they prefer to leave these wounds open. Definitive closure of areas of wide destruction in recurrent carcinoma should be deferred until the lesion is controlled. A thin skin graft, however, is useful to convert a wide-open draining wound into a closed clean one. Close follow-up and observation to detect recurrence or metastasis are the responsibility of the physician. The presence of the grafts will not inhibit the detection of recurrence.

According to Brannon and Fisher,[98] adenoma of the ceruminous glands is an extremely rare tumor in the external auditory canal. It is a clinically benign tumor occurring in the skin of the external auditory canal.

Gisselsson [99] reported a primary squamous-cell carcinoma localized on the tympanic membrane (the external layer of the upper half of the drum).

Liebeskind [100] briefly reviewed the literature concerning carcinoma of the external auditory canal, middle ear, and mastoid; he presented five new cases of squamous-cell carcinoma in this region.

Coachman [101] presented a case of cholesteatoma in the middle ear of a 38-year-old man who gave a history of perforation of the membrane and intermittent drainage from the ear since infancy. Examination of tissue taken from the mastoid, antrum, and middle ear disclosed squamous-cell carcinoma.

Dalley [102] reported on 26 patients suffering from neoplasms of the mastoid, middle ear, and external auditory canal. The lesions in these patients included squamous-cell carcinoma (17), glomus jugulare (2), melanoma (2), and 1 each of schwannoma, fibrosarcoma, eosinophilic granuloma, ceruminoma, and hemangioma. Otorrhea and pain were the commonest symptoms. Only three patients had enlarged lymph nodes when first seen, and in two of these this change was of doubtful significance. The parotid gland was involved in four patients. Any patient who has an early tumor in this situation should receive radical surgical treatment first, followed by radiotherapy. In practically all cases, death is caused by local recurrence and cachexia, rather than by dissemination of the tumor.

Wahl and Gromet [103] stated that intrinsic carcinomas of the ear (middle ear and mastoid) comprise about 1.5% of carcinomas about the ear. The cancers are usually squamous-cell epitheliomas. In practically all cases reported in the literature the patient gave a history of chronic infection of the middle ear. Sudden deafness in a patient who has an imperforate tympanic membrane without a history of recent otitis or other inflammatory processes that may affect hearing should lead one to suspect the presence of a tumor of the middle ear. Radical mastoidectomy cannot be done on every patient who has a chronically draining ear, but exploration should be done in any case in which granulations or polyps develop in the ear or recurrence of drainage is present, with otalgia. Complete radical mastoidectomy is the surgical procedure of choice, to be followed by both radium and x-rays.

A brief résumé of the incidence of intrinsic cancer of the mastoid process and middle ear was given by Means and Gersten,[104] who added a report of an authentic case to the relatively meager literature. Their case was considered unusual because of the absence of aural discharge, the presence of an intact tympanic membrane, and the minor role of pain in an advanced lesion.

Campbell and co-workers [105] presented a case of adenocarcinoma of the middle ear of at least two years' duration, in which treatment consisted of complete resection of the petrous pyramid, mastoid, and squamosa. Death resulted from recurrence 16 months later. This report indicates the feasibility of complete removal of the temporal bone for malignant lesions confined to the middle ear and petrous bone.

Johnson and Strong [106] described an unusual case of primary mucoepidermoid carcinoma of the mastoid without involvement of the middle ear or of the mastoid antrum. The lining of the mastoid is merely an extension of that of the middle ear. Consequently, it would appear permissible to postulate that any tumor arising in this region with characteristics of salivary-gland origin could have arisen from cells that had retained some of the developmental potentialities of the primary germ layer, the pharyngeal entoderm.

Neoplasms of the intratemporal portion of the facial nerve are extremely rare. They appear, as a rule, early in middle life. Guttman and Simon [107] stated that the first and frequently the only symptom is a peripheral type of facial paralysis that progresses slowly for months or years before becoming complete; it is not accompanied by pain or headache. Tinnitus, nerve (perception) deafness, and dysequilibrium, as seen in tumors of the auditory nerve, are absent. Deafness comes on later in the disease and is of the conductive type. Otorrhea may appear, and the external auditory meatus may contain neoplastic tissue. Intracranial complications are not common. The prognosis in neurinomas and neurofibrosarcomas of the intratemporal portion of the facial nerve is good as far as life is concerned but poor as far as recovery from facial paralysis is concerned.

Harris and Spencer [108] reported a case of eosinophilic granuloma with the unusual finding of bilateral mastoid involvement proved at biopsy.

Eosinophilic granuloma is of importance to the otologist, as it may select the temporal bone on one or both sides for its initial, and sometimes its only, attack, according to Dingley.[109] X-ray examination provides the only certain evidence short of exploration and biopsy on which a diagnosis can be made, as the roentgenographic appearance is unmistakable, resembling no other lesion found in the temporal bone. Dingley described an eosinophilic granuloma of both temporal bones in a 2-year-old boy.

Osteomas may arise from any part of the mastoid process but most commonly come from the cortex. They vary greatly in size, shape, and position. They may manifest themselves as a lump behind the ear or may encroach on the meatus, causing deafness; in this situation, they must be distinguished from relatively common exostoses. Osteoma of the mastoid process is a relatively rare tumor. In 1940, thirty cases had been noted; few have been reported since. Neil [110] pre-

sented a report of a cancellous osteoma of the facial ridge associated with a cholesteatoma.

Alexander and associates [111] gave an excellent short review of tumors of the glomus jugulare (nonchromaffin paraganglioma or carotid-body tumor) with extension into the middle ear. They presented a case of tumor of the glomus jugulare in a 35-year-old Negro woman. The intracranial extent of the tumor was demonstrated by carotid angiography. X-ray therapy produced definite improvement.

Tumors of the glomus jugulare have no gross characteristics that distinguish them from ordinary inflammatory aural polyps, for which they are often mistaken, according to Weille and Lane.[112] The fact that profuse hemorrhage may occur from the slightest trauma offers a clue to their correct diagnosis. Pulsating tinnitus synchronous with the heart beat is present. The progressive, locally expansive type of growth produces areas of destruction in the temporal bone. The surgical difficulties encountered in dealing with this locally invasive neoplasm are chiefly the risk of hemorrhage, recurrence, possible metastasis, danger of facial paralysis from local invasion or surgical trauma, and inability to employ conventional anatomic landmarks in the operation. Facilities for transfusion should be instantly available in the operating room, and efforts should be made to limit direct trauma to the tumor to the shortest possible time. Bone is removed until the mass is widely exposed; rapid dissection is then done, with removal of all the gross tumor except in the floor of the hypotympanum. After a dry field is obtained, the residual tumor is teased away as far as possible without eliciting serious bleeding. Metastasis has occurred in only 2 of 31 cases.

Land [113] reported a case of tumor of the glomus jugulare involving the middle ear.

Riemenschneider and co-workers [114] reported two cases of tumor of the glomus jugulare and emphasized the roentgenologic findings. Roentgenograms of the skull in early lesions give the appearance of chronic sclerosing mastoiditis. Later massive destruction of the petrous pyramid is seen, with or without a mass in the posterior portion of the nasopharynx. This destruction is most pronounced in the lower portion of the pyramid, with the ridge left as a shell above. Vertebral angiograms demonstrate the tremendous vascularity of the tumor and the displacement of normal structures as a result of the space-occupying lesion.

Rosen [115] reported three cases of glomus jugulare tumor of the tympanum with intact drums. In two of the three cases the drum was flat and normal. The technique described for biopsy exposes the tympanum for inspection of the extent of the tumor and avoids the severe hemorrhage occasioned by incision of the drum. For biopsy an incision is made through the skin of the bony canal from the 3 to the 9 o'clock positions about 5 to 7 mm. external to the drum. The incised skin is separated from the bone as far as the drum. The drum is then lifted out of its sulcus and reflected upward on itself, thus exposing the lower half of the tympanic cavity.

Tamari and associates [116] presented two new cases of glomus jugulare tumor of the middle ear and mastoid. They discussed the characteristic pathologic picture and suggested a regimen of treatment.

Ballantyne [117] presented a case of glomus jugulare tumor of the right middle ear with what was thought to be a carotid-body tumor on the left side of the neck.

Salkeld [118] reported a case of glomus jugulare tumor.

Winship and Louzan [119] presented a case of glomus jugulare tumor in which the lesion arose from the promontory of the tympanum and had no relation to the dome of the jugular bulb. They stated that 80% of these tumors occur in women. The pathologic diagnosis is established at the average age of 43.8 years. The mortality rate is 34%. Strong familial tendencies are present.

Brown [120] reported clinical observations concerning six patients who had glomus jugulare tumors of the middle ear proved at biopsy. The most constant initial symptoms were tinnitus and impaired hearing. Surgical

enucleation of the tumor, together with irradiation, constituted the treatment. Ligation of the external carotid artery did not serve to control the hemorrhage that occurs when the tumor is being removed from the middle ear. The postauricular approach appeared to be more advantageous than the endaural because of wider exposure.

Rosenwasser [121] reviewed the literature and considered the symptoms, pathology, and treatment of glomus jugulare tumor of the middle ear.

Mattick and Burke [122] reported three cases of glomus jugulare tumor.

Cleary [123] stated that the cases of glomus jugulare tumors reported, including his own case, numbered 62. Metastatic lesions have been recorded in three cases.

Magarey [124] discussed the nomenclature of glomus jugulare tumors and briefly reviewed the literature. He presented four new cases.

Black [125] discussed the nomenclature, incidence, situation, extension, metastasis, histology, clinical picture, prognosis, and treatment of tympanic body tumors. Six illustrated cases are presented.

Copps [126] expressed the belief that tumors of the glomus jugulare are a well-established clinical and pathologic entity. What is not so well established is an agreed line of treatment. He considers that these tumors may not be so radioresistant as heretofore supposed; irradiation therapy alone might be given in early stages. Up to the present, most of the cases in which successful results were obtained appear to be those with early lesions in which treatment consisted of radical operation on the mastoid, often supplemented by radiation therapy, or in which early recurrence was controlled by the latter.

Brown and associates,[127] at the Mayo Clinic, reviewed the records in 150 cases of unilateral acoustic neurofibroma in which an operation was performed, and in which the diagnosis was confirmed by microscopic examination of tissue. Some degree of deafness was present in all cases. Commonly the deafness was complete or severe, but occasionally it was mild or atypical; in the latter cases, labyrinthine function was more severely depressed than cochlear function. The finding of a nonfunctioning vestibular labyrinth on the side of the neurofibroma with retained activity of the vertical and horizontal semicircular canals on the opposite side was the usual result of caloric stimulation. Any degree of nerve deafness, with or without disturbed equilibrium, in the presence of spontaneous nystagmus, decreased corneal sensitivity, atypical facial pain, paresthesias of the face or tongue, unexplained headache, facial weakness, visual disturbance, or ataxia, is suggestive of an intracranial lesion and indicates that complete cochlear and labyrinthine evaluation should be carried out; roentgenologic examination of the head, examination of the ocular fundi, and neurologic consultation are also in order. The finding of signs suggestive of intracranial disease on the side opposite that of the deafness does not rule out the possibility of acoustic neurofibroma.

In the majority of instances, patients who have tumors of the eighth nerve consult the otolaryngologist first; he should be capable of localizing the lesion and determining its extent and probable operability, according to Rockowitz and Lerner.[128] Eight per cent of all intracranial tumors are acoustic neurinomas. The first and foremost symptoms of acoustic neurinoma are deafness and tinnitus; only later in the disease do recurrent attacks of vertigo occur. Early in the course of the disease there is loss of low tones, with little disturbance of high tones. Later, as the space-taking lesion obliterates the internal auditory meatus, complete pressure atrophy occurs, producing absolute nerve deafness. Classically, there is a dead labyrinth on the diseased side, with impairment of the vertical canals on the opposite side. As a rule, the degree of vestibular disturbance parallels the size of the lesion, but this is not always true. Acute disturbances in the circulation of the labyrinth may be present, and attacks much like Ménière's syndrome may occur. The patient falls to the side of the lesion, and the vertigo is usually rotational and purely labyrinthine in origin.

Spontaneous nystagmus is common, and peripheral facial paralysis may develop later in the course of the disease. The absence of erosion of the bony circumference of the internal auditory meatus in no way rules out the presence of acoustic neurinoma.

Roentgenologic diagnosis by means of vertebral angiography, together with the operative findings in 14 cases of tumors of the acoustic nerve, was described by Olsson.[129] The value of the method appears to be established.

Rosendal and Ewertsen [130] expressed the belief that, of the roentgenologic views most frequently employed, Runström's II projection affords the best means of depicting the antrum and the recessus epitympanicus and of demonstrating destruction in cholesteatoma. A new projection by these authors permits better demonstration of the anatomic features of the middle and the inner ear. In these projections, the antrum and the recessus epitympanicus are seen free of the labyrinth.

Ojala and Saxén [131] selected 30 temporal bones showing pathologic changes in Shrapnell's membrane and Prussak's space from a series of 110 temporal bones. The prime prerequisite for the development of cholesteatoma is that the normal correlation between epidermis and corium has been destroyed by an inflammatory process. Mere indrawing of Shrapnell's membrane does not lead to attic cholesteatoma without an inflammatory process. Acute otitis with perforation in Shrapnell's membrane may lead to attic cholesteatoma. Cholesteatoma may develop from Shrapnell's membrane even in the absence of a perforation. A decisive factor in the origin of attic cholesteatoma and cholesteatoma of the middle ear in general is that the epidermis has had time to grow between the mucosal epithelium and the bony wall of the tympanum before cicatrization of tissue takes place. An additional prerequisite is that the mucous membrane remains hyperplastic after cessation of the inflammation and does not become completely fibrous. Use of modern drugs can prevent the development of cholesteatoma from a perforation in Shrapnell's membrane due to an acute otitis. Too short a period of treatment in patients not under observation may result in asymptomatic mastoiditis and chronic otitis, perhaps giving rise to attic cholesteatoma as a result of atypical epidermal proliferation. Attic cholesteatoma always must be treated surgically to avoid recurrence. The cholesteatomatous membrane should be wholly removed. Recurrence is not due to tumor-like properties of the cholesteatomatous membrane but to the fact that hidden under this membrane there may be infected mastoid cells that maintain atypical proliferation of epidermis.

Tamari and Fogo [132] defined cholesteatomas as globular masses composed of horny and desquamated epidermis and occasional cholesterol crystals surrounded by a thin shell of epidermis and connective tissue; they develop from epithelial remnants deposited during embryonic development and are the true cholesteatomas. Pseudocholesteatomas that occur in the middle ear and mastoid associated with chronic and recurrent aural discharge and marginal perforations of the pars tensa or pars flaccida are termed "secondary pseudocholesteatomas," whereas primary pseudocholesteatomas develop as a result of early inflammation of the middle ear without perforation. A true cholesteatoma of unusual dimensions with insignificant symptoms despite the absence of the tympanic membrane, posterior bony canal, and lateral attic wall was reported. Its immense size and weight of 14 gm. make it one of the largest cholesteatomas yet reported.

Cholesteatomas may be found in various bones of the skull. As already indicated, they are supposed to be epithelial nests that for some unknown reason begin to grow, forming a tumor that desquamates the cornified layers of its stratified squamous epithelium into a central cavity. Laub [133] considered the appellation "cholesteatoma" to be improper because cholesterol is often absent. Furthermore, cholesterol often is found in chronic discharges when no tumor can be found. Epithelial growth has been found in temporal bones in the absence of

perforation or previous infection. He reported on a 72-year-old man who complained of a lump behind his right ear. The patient had perfectly normal ear drums. Histologic examination and surgical findings established the diagnosis of primary cholesteatoma.

Poushter [134] described a cholesteatoma of the middle ear in a 5-month-old infant who had no previously known ear trouble. This case proves that cholesteatoma cannot be ruled out because of the duration of the aural discharge or the age of the patient.

Henner and Tamari [135] pointed out that repeated attic discharges may simulate external otitis. The presence of a normal-appearing tympanic membrane does not exclude cholesteatoma. Loss of hearing, paralysis of the facial nerve, conduction deafness, vertigo, and headache may be the first signs of cholesteatoma. Attic perforation in acute infection of the middle ear is associated with cholesteatoma, no matter how minute. Careful history and x-ray examination of the temporal bone often reveal an unsuspected cholesteatoma. Cholesteatomas always should be treated surgically in cases in which the tympanic membranes appear intact or have only small perforations.

Harpman [136] showed that cholesteatoma may be present in the middle ear, associated with an extremely short history of ear trouble, an absence of otorrhea, an imperforate ear drum, and normal mastoid cells. His cases lend support to the views that cholesteatoma of the middle ear may be of congenital origin or due to invasion of the middle ear from the external surface of the eardrum. They neither support nor refute the view that cholesteatoma may arise also as the result of metaplasia of epithelium in the middle ear. Formation of granulation tissue in the presence of aural cholesteatoma evidently may be a reaction to the presence in the tissues of cholesterol crystals and perhaps of keratin.

Peterson [137] recorded 11 cases of cholesteatoma after use of primary skin grafts in the cavity resulting from radical mastoidectomy. These cholesteatomas may form as the result of an inflammatory desquamative reaction in primary skin grafts that have become overgrown by granulation tissue. The question is raised as to the advisability of using such skin grafts.

Walsh and co-workers [138] stated that little evidence exists that pressure necrosis is the sole reason for bony destruction in cholesteatoma. Whether infection, chemical lysis, or connective-tissue growth with consequent change in vascularity or all these factors play a part has yet to be determined. However, it appears important that the matrix underlying the epithelium should be removed if any operative work is to achieve success.

LARYNX

Malkin and Kirchner [139] expressed the belief that the family physician has the all-important responsibility of making an early tentative diagnosis of cancer of the larynx and then, without delay, referring his patient to an otolaryngologist for confirmation and specific treatment. They studied the records in 235 cases of cancer of the larynx seen at the New Haven Hospital over a period of 30 years; in 141 cases (60%), some type of treatment had been given previously. In 87% of these cases, symptomatic therapy alone had been given. Fourteen per cent of the initial laryngeal biopsies in this series were reported as negative for malignancy; three or more biopsies were required in 31% of these cases before a diagnosis was finally made. The importance of early diagnosis and treatment is indicated by the fact that of the patients who lived five years or more, 40% were treated within 6 months and 81% within 18 months of the onset of symptoms. Close follow-up by a competent otolaryngologist is necessary in any case of "chronic laryngitis" in a patient more than 40 years of age.

Kennaway and Kennaway [140] reported that the incidence of cancer of the lung in both sexes and of cancer of the larynx in men is higher in urban than in rural districts; cancer of the larynx in women shows the reverse relationship. In contrast to cancer of the lung, the prevalence of cancer of the larynx appears to be decreasing in men and to have

been stationary for the last 15 years in women. Hence, the increased consumption of tobacco in recent years has not affected this form of cancer.

In Arkansas, from 1940 through 1950, there were 42 carcinomas of the larynx reported to the central cancer registry. Brizzolara [141] noted this to be only about 1% of all cancers reported to this organization, as compared with an incidence of 2% for the nation.

The history, symptoms, differential diagnosis, biopsy, location, and extent of carcinoma of the larynx were discussed by Clerf and associates.[142]

McKenzie [143] stated that biopsy for suspected carcinoma of the larynx would appear to be simple but that difficulties are present; among these is the relatively small number of cases seen by the average laryngologist in his whole career. Biopsy evidence of malignant disease should be obtained before treatment is instituted. Obtaining a specimen for biopsy should be done by an experienced person, for there may be considerable difficulty in deciding on the extent of the growth. If no obvious cause for hoarseness can be found, or if a patient is not responding to treatment directed at the probable cause, direct laryngoscopy and biopsy should be undertaken. Biopsy after irradiation is difficult, and negative results of the pathologic examination must be interpreted with caution.

At the Royal Cancer Hospital, according to Lederman,[144] cancer of the larynx is divided into three classes, namely, supraglottic, glottic, and subglottic. The following scheme is employed for staging cancer of the larynx: Stage I—the tumor is limited to the tissue of origin, and the larynx is freely mobile. Stage II—as Stage I, but the mobility of the larynx is impaired, or the tumor has extended beyond its tissue of origin but is still within the confines of the larynx, which retains some degree of mobility. Stage III—as Stage II, but the affected part of the larynx is fixed, or extralaryngeal spread has occurred. Stage IV—contralateral, bilateral, or fixed nodal metastasis is present.

Leborgne [145] attempted to classify carcinoma of the larynx according to different anatomic sites and according to the extent of the growth. He considered that one of the great needs of research undertaken to improve methods of treating cancer is the adoption of uniform classification and staging of the disease in the common sites.

Niskanen [146] reported that keratotic epithelial changes of the larynx can be produced by different causes. Experimentally, it appears that metaplasia and carcinogenesis are not closely related. It can hardly be assumed that keratotic laryngeal changes always have the same significance as a precancerous stage. Reversible changes can be involved, but it is obvious that in some cases carcinoma develops on the basis of originally benign keratosis.

Carcinoma in situ is the earliest form of recognizable cancer. The alterations in cellular structure and arrangement are unquestionably neoplastic, but invasion is absent. Preinvasive carcinoma in situ is clinically invisible, but more frequent biopsy and greater use of exfoliative cytology are making carcinoma in situ relatively commonplace. Votaw [147] stated that until a better method is available for early diagnosis of carcinoma in situ of the larynx reliance must be placed on constant vigilance, unrepressed suspicion, more biopsy and cytologic studies, and the collaboration of an experienced pathologist.

Altmann and co-workers [148] pointed out that intraepithelial cancer of the larynx shows essentially the same cellular characteristics as ordinary squamous-cell epithelioma. The main distinguishing feature is its peculiar spread within the epithelium instead of infiltrating growth into the underlying stroma. The diagnosis of cancer can be based on these cellular changes within the epithelium alone and need not depend on the presence or absence of infiltration. Therefore, cancer in situ is regarded as a true cancer from the very beginning, and not as a precancerous condition. The diagnosis is sometimes extremely difficult, and several biopsies are often needed to confirm it. The

disease is about 10 times as frequent in men as in women. In contradistinction to carcinoma in situ of the cervix, the age incidence in the larynx is the same as for infiltrating cancers. The tumors originate from areas covered with stratified squamous epithelium, most frequently the anterior third of the vocal cord, and spread from there into the adjacent areas, sometimes even across the anterior commissure into the other cord. The size of the lesions and the onset of infiltration are not so much a question of the duration of the disease as of the rate of growth of the tumor tissue. In view of the lesser degree of malignancy of cancer in situ, treatment can be more conservative than in infiltrating cancers. Radiotherapy evidently has a better chance for success in these lesions than in extensively infiltrating cancer and should be seriously considered, particularly in those cases in which laryngectomy is the only alternative.

Up to about 30 years ago, the treatment of laryngeal carcinoma was purely surgical. Coutard then succeeded in curing cancer of the larynx by roentgen therapy, and this treatment was gradually adopted. More or less firm agreement exists that those lesions which can be treated by laryngofissure and excision are also suitable for irradiation. However, when the tumor is too widespread for laryngofissure and excision, and when only laryngectomy presents a prospect of radical removal of the tumor, opinions differ as to the value of irradiation. Jacobsson [149] treated cancer of the larynx by an apparatus containing 5 gm. of radium. The treatment was given over a period of 12 to 19 days, and the dose was generally 6,000 to 6,500 r. By radiotherapy alone, he obtained five-year cures in 42 of 106 patients (about 40%). In cancer of the vocal cords, 19 of 24 patients (79.1%) obtained five-year cures. When the lesion was so widespread that the only possible surgical procedure would have been laryngectomy, 18 of 46 patients (39.1%) obtained five-year cures. There is risk that an originally operable tumor may become inoperable during or after irradiation. However, radiotherapy has not appeared to complicate a later operation or involve the risk of necrosis after such operation. All patients received irradiation, either alone or in combination with operation. In the entire series, a five-year survival rate of 57% was obtained; in those receiving only radiation, the rate was 44%.

Gisselsson and Lindgren [150] considered radiotherapy as the method of choice for small laryngeal cancers on a cord with unimpaired mobility and for epiglottic cancer. Radiotherapy offers poor prospects in advanced lesions. Preoperative radiotherapy may be useful in doubtfully operable cancers. Postoperative irradiation should be given in all cases in which the operation has not been radical.

According to Liverud,[151] primary laryngofissure is preferable in cases ideally suited for this procedure. Primary irradiation should be given in all other cases in which laryngofissure is contemplated. If one has to choose between primary laryngectomy or radiotherapy, the former is preferred in cases of fixation of the vocal cords and in subglottic tumors. When radiotherapy fails, surgical treatment should be given. Reiteration of radiotherapy seldom leads to a cure and may complicate later surgical intervention or cause radiation injury.

Mason and Ormerod [152] maintained that in suitable cases of cancer of the larynx as good, if not better, results can now be expected from teleradiotherapy as from interstitial irradiation. There are, however, certain occasions when the slight operation and the short period of treatment associated with interstitial irradiation are more appropriate than the more prolonged and trying course of teleradiotherapy, which lasts from six to eight weeks, with one or two exposures a day. The indications for interstitial irradiation and for laryngofissure are about the same. The neoplasm must be restricted to the anterior two-thirds of the cord and extend neither up nor down. A window is made in the thyroid cartilage. The radium needles are kept outside the soft tissues of the larynx and so arranged that they form a palisade with their ends and inactive portions tucked

between the remaining cartilage and perichondrium. Eight patients received this form of treatment; one died of the disease, and two had laryngectomy later.

X-ray therapy in selected cases of early and moderately advanced carcinoma of the larynx is regarded as the optimal method of treatment for functionally satisfactory results, according to Garland.[153]

Caulk [154] presented a comparison between the survival rate and the anatomic site of origin in cancer of the larynx and hypopharynx in which the primary treatment was by roentgen rays. He concluded that advanced cancer in the hypopharynx and larynx, regardless of the site of the origin, offers a poor prognosis from the standpoint of roentgen therapy. Patients requiring previous tracheotomy have a poor prognosis. Hoarseness and associated dysphagia are exceedingly poor prognostic signs, regardless of the site of origin of the lesion. Noninfiltrating cancer originating in the true cord is curable in 78% of cases, regardless of the extent of the disease.

Ruckensteiner [155] described a technique for the treatment of intrinsic cancer of the larynx by short-distance irradiation through a fenestration in the thyroid cartilage. Patients were treated on six consecutive days. Since 1947, he has treated 35 patients; eight required laryngectomy later, 3 died, and 3 had recurrences and further irradiation. The remaining 21 are alive and well (5 for four years and 4 for three years).

From 1941 to 1946, fifty-nine patients were treated by Baclesse [156] by total laryngectomy systematically followed by roentgen therapy; 31 (52%) remained clinically cured after three years or more. This series included 43 cancers of the vestibule, 11 subglottic and fixed glottic cancers, and 5 laryngeal cancers extending to the pharynx.

Lederman [157] considered that radiotherapy is the treatment of choice in all cases of supraglottic cancers, whereas surgery is the treatment of choice for most subglottic cancers. Early lesions affecting the anterior half of the subglottic space may be treated by radiotherapy. Radiotherapy is the treatment of choice for early operable glottic cancer suitable for laryngofissure, for moderately advanced lesions retaining some mobility of the cord, and for some inoperable lesions. Operation for glottic cancer is recommended in the presence of fixation of the cord, perichondritis, recurrence after radiation or previous operation, or malignant change in precancerous lesions. He favored teleradium over x-rays.

Breed [158] reported on four patients who had cancer of the larynx treated intralaryngeally by radon; a special instrument was used that contained a gold capsule with two standard radon tubes inside. The instrument was introduced into the larynx under direct vision.

Garland and Sisson [159] reported their experience with 132 cases of cancer of the larynx in which roentgen therapy was used. Sixty-nine cases were suitable for five-year analysis; the lesions were intrinsic in 31 and extrinsic in 38 of these cases. Of the "determinate" group of 44 patients, 13 (30%) were alive and well after five years.

Occasionally an early carcinoma on a vocal cord appears so limited in extent that one wonders whether an operation such as laryngofissure is necessary to eradicate so small a lesion. Such a growth can be removed by the intralaryngeal approach, providing it is unilateral, of a low grade of malignancy, and completely surrounded by normal tissue. If there is any question at all about the lesion being too extensive for intralaryngeal dissection, laryngofissure should be done. Leucoplakia and keratoses are also indications for intralaryngeal extirpation. Successful removal of these highly localized lesions of the vocal cord is best accomplished by means of suspension laryngoscopy, with anesthesia induced by means of thiopental (Pentothal) sodium and curare. LeJeune [160] reported a series of 49 cases with only 3 recurrences; the curability rate was 93%. Occasional failure of the vocal cord to regenerate after laryngofissure leaves a large empty space, which is responsible for a poor voice. In such conditions, the voice can be improved con-

siderably by resection of the thyroid alae on the affected side; this allows the soft tissue to collapse medially.

Hemilaryngectomy, which has been used widely in France, has never been favored in the United States, but recently it has been revived. Jackson [161] has done a number of hemilaryngectomies, but for lesions not requiring total laryngectomy he generally has done either the simple clipping type of laryngofissure or one of the anterior commissure operations. He strongly defended laryngofissure and "narrow-field" laryngectomy but emphasized the importance of adhering to rigid indications for these conservative procedures. Laryngofissure must not be used for excision of lesions reaching the posterior commissure or impairing mobility or for lesions extending subglottically. Prophylactic dissection of the neck should be done in all advanced lesions, especially supraglottic lesions treated by total laryngectomy.

Broyles' [162] window laryngofissure operation is a procedure for the removal of small malignant growths confined to the true vocal cords when no fixation of the arytenoid or lagging of the movement of the cord is present. This procedure has been used for only three years, and no statistical report is given.

In the surgical treatment of carcinoma of the larynx, the all-important objective must be complete eradication of the disease. Preservation of laryngeal function with maintenance of an intact respiratory tract is of secondary consideration, according to Som.[163] However, total laryngectomy need not always be resorted to if a more conservative procedure, such as thyrotomy, hemilaryngectomy, or pharyngectomy, will save the larynx without too great an additional risk of recurrence. Hemilaryngectomy heretofore has been performed rarely because the resulting contracture of the glottis generally renders the airway useless. The final decision to do a hemilaryngectomy can be made only after adequate exposure of the neoplasm by thyrotomy with thorough exposure of the extent of the tumor. The use of an acrylic obturator, combined with mobilization of the pharyngeal mucosa for plastic closure, has succeeded in maintaining an adequate airway and in preserving a fairly good voice.

Douvlaris [164] advised the use of a sheet of tantalum to replace the portions of the alae of the thyroid cartilage removed during operation for carcinoma of the larynx.

Hall [165] suggested that in limited cordal cancer surgical treatment still gives a better chance of survival than any other method, although when voice is essential the results of irradiation are so good that this requirement may tip the scale in favor of radiotherapy without seriously reducing the patient's chances.

In studying 193 patients who had cancer of the larynx and in whom thyrotomy was done, O'Keefe [166] noted that 117 (60.6%) were living and free of recurrence. Recurrent lesions were present in 42 cases; they occurred locally in the larynx in 29, in regional lymph nodes in 6, and as remote metastatic tumors in 7. All local recurrences were due to incomplete removal. Carcinoma entirely contained on the anterior portion of the middle third of the vocal cord without involvement of the anterior commissure or extension to the opposite cord and without any evidence of impairment of mobility is a suitable lesion for thyrotomy. To hold laryngectomy as a secondary or reserve procedure in event of recurrence after thyrotomy is not justifiable. Of 176 patients treated by laryngectomy, 81 (46%) are living and free of recurrence. In this group there were 57 instances of recurrence: 41 to regional lymph nodes and 16 to other organs. In the selection of operations for cancer of the larynx, it is better to lean toward the radical than toward the conservative side.

McCall and Fisher [167] reported 104 cases of cancer of the larynx. Hoarseness was the only symptom in 70% of the five-year survivals. Of the patients who had intrinsic carcinoma treated by laryngectomy, 90% survived without evidence of disease for more than five years. In extrinsic carcinoma, the five-year survival rate was only 21%. The over-all five-year survival rate for laryngectomized patients was 52%.

Schall [168] studied 228 patients who had cancer of the larynx, and who were followed five years or more. The type of treatment was as follows: external irradiation, 132; laryngofissure, 23; laryngectomy, 60, and external irradiation of cord lesions, 13. The five-year cure rates in a larger series of cases seen from 1930 to 1945, according to treatment, were as follows: external irradiation, 17.7%; laryngofissure, 59%; laryngectomy, 58%, and cancer of the cord treated by x-rays, 92%.

Kirchner and Malkin [169] studied the records in 235 cases of proved cancer of the larynx. Males outnumbered females 12:1. The surgical mortality rate was 6%. Laryngofissure resulted in a 67% five-year cure rate. The over-all five-year survival rate in cases in which treatment was given was 34.2%. Radiotherapy alone yielded a 22.5% five-year survival rate.

Falbe-Hansen [170] maintained that, even when highly developed x-ray treatment is available, laryngectomy is an indispensable method of treatment in certain forms of laryngeal cancer, especially in subglottic cancer, which is but slightly sensitive to radiation, in cancer of the vocal cord with fixation in which sterilization is out of the question, and in cancer invading the cartilage, involving a risk of necrosis of the cartilage and sepsis when radiation is used. Laryngectomy may be done successfully in cases of recurrence or when remnants of tumor are left after fractionated radiation. Two complete Coutard treatments must be considered a contraindication for the operation. Centralization of laryngosurgery is necessary in order to obtain the best possible results.

According to McCart,[171] the deaths from cancer of the larynx in Canada and in Ontario numbered 581 and 201, respectively, in the years from 1938 to 1942, inclusive; deaths during the next five-year period numbered 641 and 252. Each year, 850 laryngectomies are performed in the United States. Cancer of the larynx comprises about 2% of all human malignant tumors. Probably no anatomic form of cancer exists in which delay in diagnosis may be demonstrated more readily than in cancer of the larynx. Carcinoma of the larynx with metastatic involvement of the cervical lymph nodes should not be regarded as inoperable.

The first consideration in the cure of cancer of the larynx is early diagnosis, with improvement in surgical treatment and techniques of irradiation, according to Tucker.[172] The outlook for the patient who has cancer of the larynx is excellent. In a consecutive series of 761 such patients, surgical treatment was considered suitable for 437 patients; median thyrotomy was performed in 274 of these and total laryngectomy in 163. The five-year cure rate when median thyrotomy was done was 86%; when total laryngectomy was done, the rate was 61%.

Hoover [173] stated that the recent trend in surgical treatment of advanced cancer of the larynx has been toward more nearly complete removal of the tissues to which it may extend, namely, the hyoid bone, the prethyroid and laryngeal muscles with the epiglottis, the preepiglottic space, the cricoid, and the upper part of the trachea. In some instances, block dissection of the neck is carried out to insure the greatest possibility of cure. In irradiation therapy, the trend is toward use of supervoltage with rotation, since a larger dose of destructive rays may be delivered into the growth with less damage to surrounding tissues. A full cancerocidal dose must be delivered, no matter how small or large the growth.

Walker [174] stated that the limited laryngectomy in which the surrounding muscles, and sometimes even the perichondrium, are not removed is out of date. He expressed the belief that laryngeal fissure has few indications today. If a tumor is small enough to be cured by a fissure and partial removal of the cord, it might better be treated by x-rays initially. A lesion that is too large to be cured by partial removal of the cord should be treated by panlaryngectomy. This means removal en bloc of the entire larynx, the hyoid bone, the ribbon muscles, the posterior centimeter of the base of the tongue, and the fat, fascia and lymph nodes medial to the carotid arteries and the jugular veins.

Combined homolateral dissection of the neck with laryngectomy is advocated by Ogura [175] at the first surgical attack only for advanced laryngeal carcinoma. It has been demonstrated that in advanced carcinoma of the larynx microscopic metastasis exists in impalpable cervical lymph nodes in 38.8% of cases. For this reason, prophylactic block dissection with laryngectomy is advocated when the primary tumor involves the pyriform sinus or the aryepiglottic fold, when cordal fixation or arytenoid edema or both are present, or when carcinoma involves the subglottic, ventricular, or false-cord areas. The postoperative mortality rate after such a procedure is low (3.5%).

The great likelihood of the lymph nodes of the neck being involved in certain types of cancer of the larynx also was emphasized by Lewis.[176] He considered it advisable in extrinsic carcinoma of the larynx to do a full radical dissection of the neck whenever operation is indicated, whether it be laryngectomy or lateral pharyngotomy. He also would do dissection of the neck in advanced supraglottic growths, including glottic growths that have extended supraglottically. He was doubtful about the necessity for prophylactic dissection in subglottic growths.

Work [177] agreed that one-stage wide-field laryngectomy, with dissection of the neck, is the operation of choice in patients who have advanced extrinsic squamous-cell carcinoma of the larynx with palpable cervical metastatic lesions. This operation should be considered in patients who have primary extrinsic cancer of the epiglottis occurring below the glossoepiglottic ligaments and in patients in whom the lesions involve the true and false cords and the aryepiglottic fold, with infiltration into the posteroinferior surface of the base of the epiglottis.

Rubenfeld and Kaplan [178] presented two cases of carcinoma of the larynx; distant spread occurred along the lymphatic vessels to the thoracic wall in one and to the axillary chain in the other.

Phillips and Larkin [179] showed that laryngectomy for carcinoma of the larynx can be performed safely in the presence of active pulmonary tuberculosis when the latter is adequately controlled by streptomycin. They presented three cases.

Demetriades [180] reported a case in which total laryngectomy for carcinoma was done in the presence of cavernous tuberculosis of the lung.

Crooks [181] reported a carcinoma of the larynx in a 10-year-old boy in whom laryngofissure was done.

Levin [182] maintained that patients can now be reasonably assured of practical speech after total laryngeal resection. Mechanical aids are unsatisfactory and should be reserved for those few patients who cannot learn a more natural form of speech because of special difficulties. Esophageal speech adequately compensates for the loss of the larynx.

Bateman and associates [183] described observations on three patients who had undergone complete laryngectomy, and who had well-developed esophageal speech. The patient must gain control of the cricopharyngeal sphincter so that he can relax the sphincter and allow air to enter the esophagus during inspiration; he then must control the degree of contraction during speech so that there is maximal economy in the use of the air in the esophagus and in loss of air from the lungs.

Andrews and Kucera [184] observed 71 patients who had laryngeal carcinoma proved by biopsy. After laryngofissure the voice in all instances has been reasonably good. The development of buccoesophageal voice after laryngectomy has been variable; the most important factor appears to be the motivation of the patient.

Equen and co-workers [185] stated that in Georgia the Division of Vocational Rehabilitation financially enables laryngectomized patients to take training in esophageal speech.

Heyden's [186] investigation by correspondence revealed that of 20 laryngectomized patients who used esophageal speech, 8 were troubled with meteorism. None of 36 laryngectomized patients had any significant difficulty due to loss of closure of the glottis, such as trouble in defecating due to weak abdominal pressure. Fitness to perform physical

work was found in 67% of the patients. Increased susceptibility for respiratory infections did not appear to have resulted.

The psychic trauma incident to laryngectomy is easily as serious as the physical trauma itself and should never be underestimated in dealing with the patient after operation. Pitkin [187] expressed the belief that the patient should be told frankly before the operation that the larynx must be removed and exactly what this will mean in terms of loss of voice. Before the operation the patient should be visited by someone who has lost his larynx and has a good speaking voice; some instruction should be given in the act of belching before the operation. Lack of proper preparation is the chief cause of resentment on the part of the laryngectomized patient.

A modified electrolarynx was devised by Weisman [188] to be used by patients who have partial pharyngectomy, cervical esophagectomy, and total laryngectomy. This instrument is of value during the interim between radical operation and reconstructive procedures in giving the patient a means of communication.

Bateman [189] further elaborated on the development of esophageal speech and found that it occurred during expiration. The more skilled the speaker, the less was the loss of air with each word or sequence of words. The studies appeared to indicate that true swallowing is not part of good esophageal speech. Teaching of speech after laryngectomy is difficult; understanding the mechanism may help the speech therapist but probably will not help the patient. He also emphasized that the best teacher is the laryngectomized patient who has developed a good esophageal voice.

Formation of crusts in the trachea and around the stoma of a laryngectomized patient does occur, although it was rare in the experience of Radcliffe.[190] It is commoner in winter than at other times. A crust of the lower portion of the trachea and right bronchus formed in a patient and almost caused death. It was successfully removed with the aid of a bronchoscope and forceps.

To overcome the difficulties encountered with endotracheal intubation for anesthesia during laryngectomy and to facilitate the tracheocutaneous anastomosis when the operation is near termination, Schneiderman and Perzik [191] devised a method of inserting a latex-covered wire-wound endotracheal tube with an inflatable cuff as low as the sixth tracheal ring and below the site of the usual tracheocutaneous anastomosis. This tube is inserted as the initial step in the operation and permits the entire operation to be done without the necessity of changing the anesthetic setup.

Latella [192] reviewed 240 cases of cancer of the larynx in an attempt to determine the terminal phase and mode of death. The cause of death and terminal phases did not differ in major respects from the terminal phases in other types of cancer with metastasis. Laryngeal occlusion might be expected as a usual cause of death, but this does not occur when tracheotomy is readily available. Hemorrhage as the cause of death occurred in only 16% of the patients. Laryngectomized patients were spared the foul-smelling, painful, ulcerating, necrotic larynx so often seen in patients who were unsuccessfully treated with radiation. The bronchopneumonia so often reported is secondary to blocking of the tracheobronchial tree by accumulated secretions.

Loughead [193] presented a case of malignant melanoma, probably metastatic, involving the left true vocal cord. A review of the world literature from 1916 through 1951 revealed only two other cases in which malignant melanoma involved the larynx.

Fisher and Odess [194] reported on a 63-year-old woman who had metastatic malignant melanoma in the larynx, for which they did a laryngectomy. In a rather thorough search of the pertinent literature in English covering both primary and metastatic tumors of the larynx, they found only one case of melanoepithelioma reported.

Diegl [195] reported two cases of sarcoma of the larynx. Sarcoma can give the impression of a benign tumor both clinically and histologically. He stated that thyrotomy with exci-

sion of the sarcoma is inadequate treatment and that total laryngectomy is indicated. A ratio of 1 sarcoma of the larynx to approximately 100 carcinomas is the average.

Forty to 50 new cases of cancer of the larynx are reported annually in Denmark. Deden [196] reported a case of fibrosarcoma (neurogenic) of the larynx in which total laryngectomy was done.

Stout [197] described a carcinosarcoma of the larynx treated by laryngectomy. This tumor is similar to esophageal lesions containing a mixture of sarcoma and squamous-cell carcinoma.

Radcliffe [198] found 83 cases of true cartilaginous tumors of the larynx recorded up to 1944. These tumors usually arise from the endolaryngeal surface of the cricoid or thyroid cartilage, although a small number form in the epiglottis and arytenoids. The tumor is inactive and does not ulcerate unless traumatized. The treatment of choice consists of laryngofissure together with enucleation of the growth. Total laryngectomy may be the only means of removing recurrent tumors. They tend to spread locally, and unless radically treated they recur. Alexardler, in 1900, classified cartilaginous tumors of the larynx into four groups: (1) chondromas, which are true neoplasms, and which invade the mother substance from which they originate; (2) mixed tumors, such as chondrosarcomas; (3) tumors of general hypertrophic or hyperplastic character affecting one or all of the cartilages of the larynx, and (4) inflammatory neoplasms.

The term "hamartoma" has been used because it denotes hyperplastic development and connotes congenital existence. In a review of the literature of the past 20 years, Pitkin and Spencer [199] found no report of a chondroid hamartoma of the larynx. They reported a chondromatous hamartoma of the cricoid cartilage in a 13-month-old boy.

Sirota and Hurwitz [200] found 89 cases of chondroma of the larynx reported in the literature. Only four cases of chondrosarcoma could be found; they added another. Radical extirpation as the primary operation in cartilaginous tumors, whether they are chondromas or chondrosarcomas, is the procedure of choice. The lesion in their case was treated first by laryngofissure and then by laryngectomy. The diagnosis of a cartilaginous tumor of the larynx should be considered when an area of tumefaction is seen roentgenologically and when at laryngoscopic examination a subglottic lesion proves difficult to remove for biopsy because of its gritty nature.

Granular-cell myoblastoma of the vocal cord was discussed briefly by Somers and Farinacci,[201] who presented two case reports. Nine cases have been reported previously, only three of which are in the English literature. This is a tumor of striated muscle; it is relatively infrequent, and the commonest site of origin is the tongue. Regardless of location, the majority of these tumors are benign. There has been no report of a malignant granular-cell myoblastoma of the larynx.

Holinger and Johnson [202] found, in a study of benign tumors of the larynx, that the commonest of such tumors were localized polyps (521 cases). Next in order of frequency were vocal nodules (193), papillomas (115), polypoid degenerative lesions (112), mucous retention cysts (73), hyperkeratosis (59), granulomas (49), leucoplakia (23), pachyderma (16), prolapse of the laryngeal ventricle (10), and laryngocele (7), and the others were tumors. In the great majority of cases (97%), the site of origin of the tumors was on the true cords themselves. In every category the number of male patients far exceeded the number of female patients, except in cases of vocal nodules and of hematomas of the cord edges, in which females outnumbered males approximately 2:1.

The first case of lipoma of the larynx was reported in 1854. Since then, there have been references to some 32 cases in the literature. Only five cases of lipoma of intrinsic origin have been reported. Theoretically, these tumors may arise from (1) existing fat cells, which occasionally occur in small clusters in the walls of the larynx; (2) embryonic rests, and (3) fibrous connective tissue that still has multiple potentialities. Harbert [203] reported a recurrent lipoma of the larynx removed by transhyoid pharyngotomy.

The clinical and histologic findings in 38 laryngeal nodes removed from 35 patients were presented by Brown Kelly and Craik.[204] The so-called simple tumors of the larynx, namely, polyps, granulomas, fibromas, myxomas, angiomas, varices, and singers' nodes, are not true tumors. They indicate differing individual reactions to irritation, and are not related to the duration or severity of abuse of the voice. The localized "amyloid tumor" of the larynx is not true amyloidosis; thus, the term "hyaline tumor" or, better, "hyaline laryngeal node" is preferred. Some nodes contain thrombi and fibrinoid exudate that in susceptible persons becomes hyalinized to form the "amyloid" substance. The staining reaction of the fibrinoid material and its distribution closely parallel the changes seen in collagen diseases, to which group they consider that the hyaline nodes belong.

The incidence, etiology, pathology, and symptomatology of multiple papillomas of the larynx were reviewed and discussed by Bradburn.[205] He reported on four patients who had multiple papillomas of the larynx treated surgically, with postoperative use of oxytetracycline (Terramycin). Two patients were free of papillomas after two months of treatment; the other two patients were improved but still had papillomas.

Amarante [206] stated that papilloma of the larynx in adults is an extremely difficult problem. In children, this lesion commonly disappears at puberty. Use of estrogens has failed. Removal of the papillomas is done only to facilitate respiration. Vocal rest in the child is obtained by tracheotomy, which is always advised when the patient cannot remain under observation. He does not agree with the use of radiotherapy in the treatment of papillomas in children. In the adult he prefers the indirect method of laryngoscopy for exeresis of papillomas and for biopsy.

Ogilvie [207] reported two cases of multiple papillomas of the trachea in adults. Evidence of malignant degeneration was found in each case; metastasis to the peritracheal lymph nodes had occurred in one. Treatment should be fitted to the individual case, but local excision in combination with fulguration or cauterization of the base, with or without irradiation, should be considered. Extratracheal exploration may be necessary occasionally to determine the presence or absence of metastasis to lymph nodes.

Kirchner [208] reported on a 7-year-old girl who had fatal massive involvement of the lungs and trachea with squamous papilloma. Pulmonary extensions of a lesser degree than in this case may be commoner than is realized, since this disease is usually self-limited and seldom can be investigated as thoroughly as in this instance.

Gorrell [209] presented a review of the literature and a case of papillomatosis of the larynx with fatal termination in a 2-year-old girl.

True congenital laryngocele is a clinical entity of great rarity. Richards [210] presented a case of combined external and internal laryngocele, with a description of the surgical measures employed for eradication.

Hoover [211] recorded two cases of laryngocele and illustrated the surgical technique for their removal. He maintained that it should be possible to dissect the entire laryngocele in a single operative procedure without disturbing the anatomic structure and function of the larynx. Laryngofissure is not the primary approach to laryngoceles.

Johnston [212] gave a case report and emphasized external laryngocele in the differential diagnosis of cystic masses in the neck.

Horowitz [213] presented a few historical data and discussed the embryology and anatomy relating to Morgagni's ventricle and the sacculus. Two cases of bilateral laryngocele were given in detail.

Black [214] reported on a 26-year-old man who had a cyst of the laryngeal ventricle.

The surgical techniques for various types of laryngoceles were considered by O'Keefe.[215] He reported a case of internal laryngocele and presented a method that appears to be suitable for resection of all varieties of these lesions.

Richards [216] gave a case report of a laryngocele.

Freeman [217] recorded three cases of infected laryngocele and gave a brief review of the literature.

A brief survey of cystic swellings in the ventricular area of the larynx was presented by Laff [218] in order to emphasize their etiologic and clinical importance. The congenital variety, as found in infants, most likely is due to maldevelopment of the ventricle or its appendage, the saccule. Some congenital cysts are closely allied genetically and should be considered as manifestations of the same developmental error.

Morgenstern and Lasala [219] described four cases of cysts of the larynx. Such cysts are rare, are usually asymptomatic, and are discovered as an incidental finding. They may flare up due to infection, producing symptoms and increasing in size until they rupture spontaneously, in which case little or nothing can be found on examination, or expand greatly, producing dyspnea until, because of obstruction of the larynx, asphyxia results. A cyst that produces dyspnea should be collapsed by plunging a hard instrument through its wall.

Six cases of laryngocele associated with cancer of the larynx have been seen by Meda.[220] In four of these cases, the demonstration was exclusively roentgenologic.

Persistent thyroglossal-duct cyst is a rare complicating factor in laryngeal operations but is important because it might suggest extralaryngeal extension of a malignant tumor of the larynx, resulting in poor judgment in treatment. Two cases were reported by Figi and Johnson [221] in which a cyst of the thyroglossal duct was encountered in the course of an operation for epithelioma of the larynx.

LARYNGOPHARYNX

Sideropenic dysphagia, also referred to as the Plummer-Vinson syndrome or the Paterson-Brown-Kelly syndrome, is well known in Sweden, according to Lindvall.[222] Its connection with cancer of the hypopharynx is well known. Sideropenia is a deficiency disease apparently due to several factors, such as hereditary changes, unsuitable diet, and deficiency in iron and vitamins. In addition to hypochromic anemia, other changes include rhagades at the corners of the mouth, atrophic changes in the buccal and pharyngeal mucosa, dysphagia, changes in the fingernails, and fissuring of the finger tips. The disease occurs almost exclusively in women. Although values for iron may be returned to normal, dysphagia remains because of irreversible changes in the pharynx. The commonest roentgenologic changes are fold-like structures projecting in from the anterior wall. Circular constrictions may be found. Eight typical cases of sideropenic dysphagia are presented in which carcinoma of the hypopharynx finally developed.

Holinger and Rabbett [223] reported three cases of carcinoma of the pharynx and larynx in which the tumor developed in an area previously irradiated for a benign process. A review of the literature revealed reports of nine similar cases. The association of irradiation and the development of tumors probably is not merely coincidental. In the presence of atrophic rhinitis and pharyngitis sicca with extensive scarring and crusting associated with a history of several courses of postnasal irradiation, one must be concerned about the possibility of late development of carcinoma.

Goolden [224] presented four cases in which tumors developed in the laryngopharynx after irradiation of the neck for benign conditions 26 to 30 years previously.

The hypopharynx is a common site of cancer in Sweden. Since February, 1940, Welin [225] has seen 510 patients who had cancer of the hypopharynx in Stockholm; 206 were men and 304 were women. The incidence of carcinoma in the lower part of the hypopharynx was much greater in women than in men; this is probably connected with the high incidence in women of the Plummer-Vinson syndrome, which is considered to be a precancerous disease. In Sweden, roentgenologic examination of the hypopharynx consists of the usual soft-tissue roentgenograms plus spot films after the patient swallows opaque medium to show the mucosal pattern in posteroanterior and lateral views. Use of contrast medium provides

a much more precise idea of the appearance and extent of the tumor than can be gained from soft-tissue pictures alone. A good view of the mucous membrane is obtained on relief pictures, achieved by having the patient swallow one or two tablespoonfuls of contrast medium and then having him make several additional swallowing motions. Films made during maximal filling of the hypopharynx enable one to see the typical valvular bands of the Plummer-Vinson syndrome.

Surgical treatment for cancer of the hypopharynx that results in severe mutilation and that has given lasting results in only a few cases cannot be recommended by Hultberg,[226] except in rare instances. Even radiation treatment, however, has been only palliative in most cases. Thirteen of Hultberg's patients treated before 1943 experienced myelodegeneration due to radiation of the cervical portion of the spinal cord. Since then, techniques have been modified. A cross-fire method is used, with two fields on each side of the neck; one field is radiated each day. The total tumor dose required is about 5,700 to 6,200 r, administered over a period of 28 to 32 days. The absolute cure rate is 12.3%, and the relative cure rate is 14.5%. His results were calculated on all cases in which treatment was given, including those in which radiotherapy could not be completed.

Rennaes [227] studied 130 patients who had cancer of the hypopharynx. Five-year cures after roentgen treatment were obtained in 6%. Early diagnosis appears essential, but the effect is mainly palliative.

Rotational irradiation therapy can be used advantageously when the lesion to be treated is situated more or less in the middle of the body, when it is deep-seated, when the part of the body to be irradiated is cylindric in shape, and when the actual depth dose can be determined. This is usually the case in carcinoma of the middle third of the esophagus. Carcinoma of the hypopharynx does not lend itself so well to such treatment because the lesion is not deep-seated. However, rotational treatment of carcinoma of the hypopharynx can produce favorable results when the tumor does not extend below the level of the seventh cervical vertebra and when there are no palpable metastatic lesions, according to Gynning.[228]

The survival rate for 67 patients who had carcinoma of the cervical portion of the esophagus treated with radiation was 11.9%, according to Jørgsholm.[229] Even when early diagnosis is made, the response of these tumors to radiation differs widely. Curability appears to depend less on the maximal tumor dose than on the origin of the tumor, its manner of growth, its extension and rate of metastatic activity, and on unknown radiobiologic factors.

In the entire group of hypopharyngeal and pharyngolaryngeal tumors, the accomplishments of radiotherapy have been rather poor, according to Del Regato.[230] Supraglottic carcinomas arising from the laryngeal wall of the epiglottis, the false cord, and the laryngeal ventricle may be treated successfully by radiation. Carcinomas of the subglottic region are better treated by radical operation.

Alonso [231] described surgical methods that make possible extirpation of tumors that do not involve the glottis without removal of the vocal cords. For tumors of the pyriform sinus he performs "partial vertical laryngectomy." If the tumor involves the larynx deeply, it cannot be removed by this technique. For tumors of the epiglottic vestibule, he performs "partial horizontal laryngectomy." For tumors of the subglottic area, he performs "partial anterior or lateral laryngectomy." This group includes true subglottic tumors, anterior or lateral, and lateral tumors of thyroid origin.

The surgical treatment of cancer of the upper end of the esophagus has come into recent prominence; Livingstone [232] considered that there are three main reasons for this: (1) the disappointing results of radiotherapy; (2) the security given by antibiotics, and (3) the cooperation of plastic surgeons. The only operation undertaken should be total pharyngolaryngectomy. If possible, reconstruction of the gullet should take place at the primary operation.

In assessing the operability of lower pharyngeal and upper cervical carcinomatous

growths, Owen [233] and Lewis [234] stated that certain essential details must be determined. The degree of dysphagia should be noted; it is important to know whether or not the whole lumen is involved. The degree of mobility of the vocal cords should be gauged. The upward and downward extent of the growth should be known, as well as the presence of infiltration beyond the muscular wall to outside structures in the neck. It is wise to palpate the thyroid gland and to ascertain the mobility of the larynx when moved against the prevertebral fascia. Finally, the neck must be palpated for metastatic lesions in the lymph nodes. These details are studied by direct and indirect laryngoscopy and endoscopy and also by soft-tissue x-rays and tomograms; however, occasionally direct approach must be made through the neck before one can be certain of the downward spread of a cervical growth. Owen presented various indications for lateral transthyroid pharyngotomy. Lesions such as carcinoma of the pyriform fossa, postcricoid carcinoma, and primary carcinoma of the cervical part of the esophagus that is infiltrating into the wall of the trachea can be dealt with only by pharyngolaryngectomy. In carcinoma of the pyriform fossa it is wise to carry out a one-stage combined excision of the primary lesion and block dissection of the secondary lymph nodes; no attempt should be made to preserve the larynx, no matter how early the involvement.

Dunlop [235] mentioned the 1945 report of the Clinical Research Committee of the British Empire Cancer Campaign with records of 384 patients who had laryngopharyngeal cancer, of whom only 19 survived the five-year period; he also referred to the figures of the Holt Radium Institute (1946), which indicated that 9 out of 220 patients survived for five years. He stated that extirpative surgery of this region of the body is fraught with great difficulties. The justification of mutilating surgical treatment is the absence of a satisfactory alternative, but it can be faced with equanimity only when it is attended by a low operative mortality rate and reasonable prospects of alleviation or cure. With improved anesthetic methods and chemotherapy, major surgical intervention in this region is not attended by a high mortality rate. Removal of the larynx does not produce intolerable disability. Indiscriminate application of radiation is not preferable to surgery. Dunlop discussed the surgical treatment of 25 patients referred because of carcinoma of the laryngopharynx.

Raven [236] presented an account of his experiences in the radical surgical treatment of 18 patients who had carcinoma of the hypopharynx. He considered the best operations to be laryngopharyngectomy and laryngoesophagopharyngectomy with bilateral block dissection of the lymph nodes as either one-stage or two-stage procedures. These should be carried out even when the primary growth is relatively localized.

Contrary to true esophageal carcinoma, which often metastasizes early and widely, carcinoma that arises in the larynx and spills over into the hypopharynx or that arises in the hypopharynx and secondarily involves the larynx or the upper part of the esophagus often tends to remain localized; its metastatic lesions frequently are limited to the cervical lymphatic chains for a considerable period before ultimate dissemination occurs. Grimes and Stephens [237] reported on their experience in the surgical treatment of 17 patients who had advanced malignant lesions in these regions.

Morrison [238] stated that early surgical techniques in the management of carcinoma of the laryngopharynx were largely replaced by irradiation therapy, which reached its peak 20 years ago. At present there is a definite reversion to extensive and extended surgical intervention as the treatment of choice.

Orton [239] has seen 525 patients with carcinoma of the larynx. The condition in 59 patients was inoperable; 79 patients refused operation, and 43 had some form of irradiation therapy, leaving 344 patients who were operated on. Of the 43 patients who had irradiation therapy, none were alive after five years. The operative mortality rate was 1.7%. The location of the lesions, the num-

ber of patients operated on, and the percentage of five-year cures were as follows: cords (132), 70%; subglottic (62), 48%; ventricle (38), 55%; epiglottis (32), 65%; epiglottis and tongue (21), 62%; aryepiglottic fold (18), 16%; arytenoid (17), 58%, and pyriform sinus (24), 25%.

Daly [240] stated that an elective dissection of the neck done preferably at the time of resection of primary carcinoma of the larynx is recommended for the following reasons: 1. In all extrinsic carcinomas of the larynx and laryngopharynx, the incidence of metastasis is high (50 to 71%). 2. In carcinomas of the larynx and laryngopharynx in which the nodes were clinically negative, a high incidence of metastasis was proved by examination of surgical specimens removed in elective dissection of the neck. 3. With the neck open for removal of the primary lesion the surgeon has the best opportunity of doing a complete dissection of the neck without cutting across the lymphatic channels. 4. When dissection of the neck was delayed until the nodes became clinically positive, results were poor, as judged by control of local disease.

Brewer [241] gave a brief review of modern operative techniques employed in the treatment of carcinoma of the cervical and upper thoracic portions of the esophagus. One-stage resection of the cervical portion of the esophagus with cervicoesophagogastrectomy offers a one-stage resection of the lesion with immediate restoration of continuity of the gastrointestinal tract. Because it permits radical dissection of the neck, the multistage operation involving use of pedicle tube flaps eventually may prove to be the superior technique for treatment of carcinoma of the cervical portion of the esophagus. If only palliation can be effected, then a single-stage operation has great advantage.

Reidy [242] stated that immediate reconstruction of the cervical part of the esophagus by a free graft on a tube should not be done in the presence of a tracheotomy.

Moore and Faulkner [243] reported that recurrences are not uncommon during protracted repair of the defect that follows pharyngoesophagolaryngectomy for extrinsic cancer of the larynx. Ideally, therefore, the repair should be accomplished at the primary operation or, should the general condition of the patient not permit the further time needed for the repair, the wound should be closed in such a way that it forms the first step in a two-stage repair. The authors outlined three methods of surgical repair of such lesions.

For carcinoma at or near the mouth of the esophagus involving the posterior surface of the larynx, only one form of treatment appears adequate, namely, radical removal of a segment of the pharynx and upper end of the esophagus, together with the whole of the larynx. This conclusion has been arrived at after the observation by Negus [244] of 58 patients who had growths of this type. He agreed with many others that irradiation is unsuitable for mangement of this disease. He decided that primary reestablishment of continuity of the gullet was desirable; this was accomplished by wrapping a free skin graft around a plastic tube and introducing this tube into the cut ends of the pharynx and esophagus.

Carcinoma of the cervical portion of the esophagus is curable by surgical measures; swallowing function and a normal life can be offered people who have this lesion by simple surgical reconstruction of the esophagus, using the patient's own tissues. After the initial operation is completed, the patient usually is left with a pharyngostoma, a tracheostoma, and an esophagostoma. Watson and Converse [245] reported that although such a patient may be uncomfortable, depressed, and annoyed by the drooling of saliva after the operation, it is necessary not to hasten unduly the reconstruction of the cervical portion of the esophagus.

Edgerton [246] maintained that early reconstruction of the cervical portion of the esophagus and the pharynx is a prime requisite of any operative attack on cancer of the oral cavity, pharynx, hypopharynx, or upper part of the esophagus. Free split-thickness skin grafts appear to serve adequately to replace the lining of esophageal and pharyn-

geal segments. These skin grafts are applied by fastening them to metallic mesh.

Duncan [247] reported a so-called mixed tumor of the hypopharynx with malignant changes and distant metastasis.

When a tumor involves the lingual thyroid area, studies of radioactivity should be done to determine the exact location and function of thyroid tissue in the patient. Richardson and Lineback [248] showed that suture traction of the tongue provides an excellent exposure of the posterior third of the tongue for the surgical removal of tumors or cysts. Since cystic degeneration commonly occurs in adenomas of thyroid tissue, surgical removal is preferable to medical treatment.

Waters and associates [249] reported a lingual thyroid in a 12-year-old girl and included a review of the literature on the subject.

Schwartz [250] also reported a lingual thyroid and gave a review of the literature.

Bigger and Van Slyke [251] described a suprahyoid approach for excision of a lingual thyroid in a 10-year-old girl.

A historical review of the background of suprahyoid pharyngotomy as a means of approaching tumors on the base of the tongue was given by Blassingame.[252] The practicability of this operation for tumors in the epipharynx is established.

A case of solitary schwannoma of the pharynx was reported by Guggenheim.[253] The lesion in this case is believed to be the largest tumor of this type ever described. The growth was removed by a combined cervical and intraoral operation. A review of the literature revealed only 17 previous cases of solitary pharyngeal schwannoma cited by American authors; the international literature recorded 36.

Hanley and Davol [254] reported a neurilemmoma of the pharynx in a young woman; the lesion was removed by the intraoral route. Horner's syndrome was noted preoperatively, and this increased postoperatively, indicating that the growth arose from the cervical sympathetic chain.

Somers [255] reviewed 29 cases of neurogenic tumors occurring in the pharynx and derived from elements of the peripheral portions of the nervous system. The great majority of these tumors were neurilemmomas. He reported a case in which a neurilemmoma of the pharynx was removed intraorally.

Lipomas of the hypopharynx occur infrequently and may exist for a long time without detection. However, they may cause alarming respiratory distress and disturbances of deglutition. Removal of such relatively large tumors from the hypopharynx probably is best effected by means of suspension laryngoscopy, according to Som and Wolff.[256]

Jones [257] reported the endoral removal of a lipoma (2 by 1½ in. [5 by 3.5 cm.]) of the pharynx.

Davis [258] reported a pharyngeal polyp.

A case report of an epithelial cyst of the pyriform sinus was presented by Dinolt.[259]

A carcinoma in situ was reported by Bullock and Snyder [260] in a surgically removed pharyngeal diverticulum. The authors were unable to find a report of such a carcinoma occurring in this unusual site.

LeJeune and Lewis † reviewed the available literature on the pharynx and pharyngeal surgery for 1950 and 1951.

TONSIL

Parshall and Stenstrom [263] reviewed all malignant lesions of the faucial tonsil treated by x-rays at the University of Minnesota Hospitals during the period 1926 through 1950. Histologically these 101 cases fell into the following groups: squamous-cell carcinoma, 72; transitional-cell carcinoma, 6; undifferentiated carcinoma, 2; lymphoepithelioma, 5; lymphosarcoma, 13; leukemia, 2, and Hodgkin's disease, 1. Cancer of the tonsil is usually quite insidious; the first symptom noted in 46% of these cases was a mass in the neck. Several lesions were found on routine pathologic examination of tissue after tonsillectomy. Parshall and Stenstrom's method of treatment has been almost exclusively irradiation, although a few patients had surgical treatment of one type or

† References 261 and 262.

another. They found three-year and five-year survival rates of 35 and 26%, respectively.

In a series of 141 carcinomas and 21 lymphomas of the tonsil studied by Teloh,[264] 98.6% of the carcinomas occurred in males, whereas lymphosarcoma occurred with approximately equal frequency in males and females. Lymphosarcoma occurred in both tonsillar areas in 25% of the cases in which it was present. The commonest presenting symptom was a mass in the neck. Adenopathy occurred in 75.7% of the patients. The over-all five-year survival rate in an unselected series of 161 patients was 7.2%. All treated patients received radiation.

Two cases of anaplastic carcinoma of the tonsil with mediastinal metastasis were reported by Sammon.[265]

A combined cervicobuccal operation has been designed and performed successfully for a carcinoma involving the structures of the lateral wall of the oropharynx, including the tonsil, fauces, soft palate, and base of the tongue. Raven [266] reported one case and described the technique used.

Christiansen and co-workers [267] described a 16-year-old girl who had a fusocellular sarcoma (fibrosarcoma) of the tonsil. Examination of the literature showed only two reported cases.

It is unusual to find salivary-gland tissue lodged in the tonsillar fossa after the tonsil itself has been removed. Twelve cases have been reported. Sanderson [268] reported the 13th.

TRACHEA

Gilbert and associates [269] presented a compilation of 546 primary tracheal tumors; 92.1% occurred in adults, and 7.9% occurred in infants and children. In adults, 49.1% of the tumors were malignant and 50.9% nonmalignant. In children, 93.1% were nonmalignant and only 6.9% malignant. All the malignant tracheal tumors in children were sarcomas, and all occurred in girls. The predominant benign tumors in infants and children were papillomas (57.5%), fibromas (22.5%), and angiomas (15%). In adults, the predominant benign tumors were osteochondromas and tracheopathia osteoplastica (29.4%), followed by papillomas (16.4%) and fibromas (11.7%). In adults, 78.5% of the malignant tumors were carcinomas.

The bronchoscopist has three functions in the diagnosis of malignant lesions of the bronchus. He must ascertain the presence of a lesion, he must obtain tissue or cells for histologic or cytologic examination, and he must determine the location and, if possible, the extent of the neoplasm. Kramer and Rabin [270] suggested that carinal biopsy be performed routinely before a decision is made regarding the surgical treatment of carcinoma of the bronchus.

Two cases in which combined cervical and intrathoracic resection of the trachea was done were presented by Cotton and Penido.[271] Both patients were alive and well 16 and 6 months, respectively, after extirpation of the malignant tracheal lesion. Reconstruction of the trachea with a stainless steel tube was adequate.

A review of methods employed in the surgical repair of tracheobronchial defects was presented by Kay.[272] Resection followed by primary anastomosis when sufficient mobilization of the trachea is possible appears to be associated with fewer complications than when various types of tubes or grafts are employed to bridge the defect. The surgical management of five patients who had operations on the trachea is presented.

Clagett and co-workers [273] stated that cylindromas of the trachea are the most favorable type of tracheal tumor for surgical resection. They reported four cases in which surgical resection of tracheal tumors was performed. They cannot predict that surgical resection of tracheal tumors ever will offer a greatly rewarding field of endeavor. However, their experience thus far encourages them to continue experimental and clinical efforts.

A case of squamous-cell carcinoma of the lower end of the trachea was reported by Kergin.[274] As an emergency measure to overcome tracheal obstruction, the tumor was locally excised and the defect successfully repaired with a patch of pericardium. Later

radical resection with reconstruction using a pedicle graft of bronchus ended in failure.

Results of experimental tracheal resection in dogs, with replacement by a prosthesis, were given by Craig and associates.[275]

Evans [276] removed a large benign tracheal myxochondroma. The tracheal defect was repaired successfully by incorporation of a full-thickness skin graft enforced by stainless steel wire.

Use of a viable pedicle graft for repair of an extensive tracheal defect was described by Parker and co-workers.[277] The graft was formed from a portion of the thoracic wall and consisted of intercostal muscles, periosteum of the rib beds, parietal pleura, and intercostal vessels and nerves. An excellent blood and nerve supply was retained from the intercostal vessels and nerves that entered the pedicle graft posteriorly.

A case in which anterior mediastinal tracheotomy was performed was reported by Kleitsch.[278] The lesion was a recurring carcinoma of the larynx that had produced respiratory obstruction.

Minor [279] described recurrence within the tracheostoma after total laryngectomy for epidermoid carcinoma. The technique of tracheal excision through a mediastinal approach and transsternal tracheostomy is described.

ESOPHAGUS

Korkis [280] reported a pedunculated squamous papilloma of the upper end of the esophagus; the lesion was removed endoscopically. A short review of the literature is given.

A large benign polyp of the esophagus was reported by McBride.[281] A review of the literature is given.

Foster [282] reported the successful removal of a large polyp of the upper part of the esophagus by endoscopy. He pointed out that the endoscopist occasionally can remove completely a pedunculated benign tumor of the esophagus by a procedure that is much simpler than transthoracic esophagotomy.

A leiomyoma involving both the lower part of the esophagus and the cardia of the stomach was successfully treated by resection and esophagogastric anastomosis, according to Schnug.[283] This is the sixth reported case of such tumors at the cardioesophageal junction.

A review of the surgical treatment of esophageal leiomyomas was presented by Shoulders,[284] together with an additional case of leiomyoma found in the middle third of the esophagus; the lesion was treated by a "shelling-out" procedure.

Kiviranta [285] reported the results of an investigation based on 3,149 cases of esophageal cancer diagnosed in Finland during the years 1936 to 1947 and on 607 cases seen at the Central Institute of Radiotherapy of the University from 1936 to 1949. In the near future, deaths from esophageal cancer in Finland will exceed deaths due to tuberculosis; thus, cancer of the esophagus will become the commonest cause of death in Finland.

Parker [286] considered that roentgenologic study of the esophagus as the only procedure needed in addition to the history and physical examination is inadequate to determine the presence or absence of carcinoma of the esophagus. In any patient with any symptom referable to swallowing or eating, especially with pain or a sense of obstruction on swallowing, esophagoscopy is indicated even if roentgenologic examination shows nothing abnormal. This represents a change in his former concept to the effect that esophagoscopy was indicated only to confirm by direct observation and biopsy the character of the lesion as observed by roentgenologic examination.

Nine cases of esophageal cancer arising after corrosion were reported by Kiviranta.[287] He estimated that the possibility of esophageal cancer appearing in persons who had corrosion dating back 24 years or more is 1,000 times as great as it is in other people. The distribution of carcinoma in the esophagus corresponded to the distribution of the strictures due to corrosion.

Gore and Lam [288] added a case of carcinoma of the esophagus complicating cardiospasm to the small number previously reported.

While cancer of the gullet remains a formidable disease, the former attitude of despair has been considerably alleviated by the possibilities of removing the growth and reestablishing the act of swallowing. Sellors [289] performed a two-stage operation. The first stage is a laparotomy, during which the stomach is freed from its omental attachments. The second stage is carried out immediately, with the patient in the face-down posture for a right thoracotomy. The esophagus is exposed and isolated. The stomach is pulled into the thorax; it is so mobile that it will reach up as far as the apex of the thorax or even into the base of the neck.

Garlock [290] noted an operability rate of 46% in 161 patients who had squamous-cell carcinoma of the esophagus. The over-all operative mortality rate was 34%. Of the 49 who survived operation, 25 were alive when the report was made. Ten of these 25 had lived five years or more, 7 had lived for three to five years, and 8 had lived less than three years.

Thorek [291] stated that zoning of the esophagus into three divisions has aided in standardizing the surgical treatment of carcinoma of the esophagus. Lesions involving the midthoracic portion of the esophagus are best treated by transthoracic partial esophagectomy and partial gastrectomy with a supra-aortic esophagogastric anastomosis. Lesions involving the lower part of the esophagus and the cardiac end of the stomach are best resected by a combined thoracolaparotomy incision that does not necessitate the removal of any ribs.

Some aspects of the preoperative, operative, and postoperative management of patients undergoing esophagectomy for carcinoma were described by Rundle.[292]

Other advocates of exposure of the esophagus through the right side of the thorax are Gaspar and Snyder,[293] who said that this approach should be used in all cases of carcinoma of the esophagus above a level that is 32 cm. from the incisor teeth.

Macmanus [294] outlined some of the reasons for preferring the combined approach through the right side of the thorax in resection of the esophagus.

Rienhoff [295] described the right-sided two-stage approach to carcinoma of the middle third of the esophagus.

The results of resection and primary restoration of continuity by esophagogastric anastomosis in 254 patients who had carcinoma of the esophagus and cardia during a 12-year period were presented by Sweet.[296] The operative mortality rate among those when the report was made. Ten of these esophagus or at the cardia was 11.6%. Among those whose tumor was in the midthoracic segment, the majority of whom had an anastomosis above the aortic arch, the mortality rate was 24.3%. The five-year survival rate in patients who had carcinoma of the lower part of the esophagus and cardia was 17.5%. For patients whose growth lay in the midthoracic segment of the esophagus, the corresponding figure was 4%. Little significant difference was present in the survival rates of patients who had adenocarcinomas and those whose growths were epidermoid in character.

Seybold [297] presented a brief paper on the surgical treatment of carcinoma of the esophagus.

An analysis of the various clinical features observed in 159 patients suffering from carcinoma of the esophagus was given by Franklin and Shipman.[298]

Daniels and Chamberlain [299] stated that an aggressive approach to esophageal resection is indicated to restore gastrointestinal continuity. This result is usually best achieved by esophagogastrostomy, utilizing the right-sided technique.

No patient has survived five years after resection of a primary carcinoma of the esophagus, in the experience of Humphreys and Moore.[300] The present apparently hopeless outlook of any curative therapy in carcinoma involving the upper part of the esophagus justifies attempts to devise more radical surgical removal of these lesions.

Data concerning 172 cases of carcinoma of the esophagus or cardia of the stomach

observed in North China were analyzed by Wu and Loucks.[301]

In reviewing the course of surgical events during the past 25 years relative to cancer of the esophagus, Wolson [302] stated that much has been accomplished. The operative mortality rate has been brought within reason, more patients are seeking help at a resectable stage of disease, and the range of resectability has been extended. No deaths occurred among 14 patients who had cervical esophagectomy. In 71 esophagectomies of all types, the operative mortality rate was 11%.

Winter and Spencer [303] reported a case in which supra-aortic esophagectomy was done, with the anastomosis performed in the thorax at the level of the first rib.

One hundred patients who had squamous-cell carcinoma of the esophagus were studied by Merendino and Mark.[304] Thirty-four patients exhibited localized "curable" lesions at necropsy or operation or both. A 34% "curability" rate appears to be considerably higher than present-day surgical experience would indicate. The average age of patients who have carcinoma of the esophagus is 62 years. This factor will affect adversely the actual curability of the lesion. On the basis of operative mortality rates and life-expectancy figures alone, the percentage of patients theoretically "curable" (34%) would be reduced to a potential five-year cure rate of 20.4%.

Results of operative treatment of carcinoma of the esophagus are disappointing. It appeared justifiable, therefore, to Ravitch and associates [305] to direct efforts toward palliation rather than cure.

The patient having acute perforation of a carcinomatous lesion of the esophagus presents a problem that in the past has been managed by such conventional methods as mediastinal drainage, antibiotic therapy, and gastrointestinal decompression. Subsequent to the clearing of the mediastinitis and associated suppuration, the neoplasm was removed, provided the lesion was still operable and the condition of the patient satisfactory. Rational treatment of such a problem, according to McBurney and associates,[306] is to perform esophagectomy or esophagogastrectomy primarily without the long delay consequent to preliminary drainage. They did one-stage esophagogastrectomy in the presence of mediastinitis in three cases.

Pate and Sawyer [307] used freeze-dried esophageal grafts to replace the middle third of the esophagus in five animals. These experiments ended uniformly in failure.

Berman ‡ replaced a resected portion of the esophagus containing a carcinoma by a plastic tube that maintained continuity with the stomach. Eight months after operation the tube was removed by esophagoscopy, leaving a functional epithelialized fibrous sheath to maintain continuity. The patient lived for 10 months in comfort, finally dying of metastasis. This procedure has been employed in 28 instances of carcinoma of esophagus by Berman. Regional extension of the disease was present in 95%. The operative mortality rate has been less than 10%. No regurgitation or evidence of esophageal irritation has been present in patients followed for more than a year since the operation. Patients eat full meals. The tube may remain permanently or be removed in 60 days.

Gynning [310] gave a short report on the therapeutic technique used at the Jubilee Clinic in Lund, Sweden, for rotational roentgen treatment of intrathoracic carcinoma of the esophagus. Of a total of 88 patients treated, 8 have been free of signs for at least three years.

Watson and Brown [311] showed that cancer of the esophagus can be eradicated by properly planned beam-directed x-ray therapy. Four cases, with clinical histories and postmortem findings, are reported.

A case of inoperable carcinoma of the esophagus brought to a resectable stage by preliminary irradiation was reported by Clifton and Blansfield.[312]

Buschke and Cantril [313] reported on 58 patients who had carcinoma of the esophagus. Five out of 27 adequately treated patients were clinically well when the report was made. Of 29 patients seen more than five

‡ References 308 and 309.

years previously, 19 were admitted for treatment, and 14 of these received adequate therapy. Three of these have been clinically and roentgenologically well without signs of active disease and with normal esophageal function for periods of 12, 10, and 8 years, respectively.

A case of carcinosarcoma of the esophagus was reported by Smith and Gowing.[314]

Carcinosarcomas of the esophagus are rare. Only 17 have been reported. Ende and associates [315] reported the 18th case; it is apparently the first reported instance of squamous-cell carcinoma and rhabdomyosarcoma producing a double tumor. A case of carcinosarcoma of the esophagus was reported by Thompson.[316] This was an incidental finding in a case of pulmonary tuberculosis and epidermoid carcinoma of the buccal mucosa.

Two cases of carcinoma of the esophagus were described by McKeown.[317] The tumors were identical with oat-cell carcinoma of the lung.

A primary adenocarcinoma of the lower third of the esophagus, originating in the submucosal glands, was described by Goldman and co-workers.[318] The roentgenologic appearance of the lesion belied its malignant nature, since the tumor presented no invasive qualities and no destruction of the mucosa.

Adenocarcinoma in the esophagus may arise in three ways: (1) as an upward extension of carcinoma of the stomach; (2) from mucous glands that are normally found in the esophageal submucosa, and (3) from ectopic gastric mucosa. The first event is not uncommon; the second and third are rare. A case of congenital short esophagus was described by Morson and Belcher.[319] The lower half of the gullet was lined by ectopic gastric mucosa that was affected by inflammatory and atrophic changes. A carcinoma had developed at the squamoglandular junction.

Nine cases have been reported in the literature as leiomyosarcomas of the esophagus. These tumors are usually at the lower end of the esophagus, as smooth muscle predominates there. The 10th case of leiomyosarcoma of the esophagus was reported by Neil and Horne.[320]

A case of Hodgkin's disease involving the esophageal wall was presented by Bichel.[321] Such localization, although rare, has some practical importance, as irradiation in several cases has rendered the patient free of symptoms for long periods.

A case of primary melanosarcoma of the esophagus causing obstruction was described by Burnett and St. John.[322]

The third case of what is interpreted as primary melanocarcinoma of the esophagus was presented by Bullock and associates.[323]

A case of melanocarcinoma of the esophagus with metastasis to the paratracheal lymph nodes in a 55-year-old woman was presented by Garfinkle and Cahan.[324]

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Society Transactions

AMERICAN LARYNGOLOGICAL ASSOCIATION

Gordon F. Harkness, M.D., *President*

Harry P. Schenck, M.D., *Secretary*

Abstracted by Samuel Salinger, M.D.

Seventy-Fifth Annual Meeting, Boston, May 27-28,1954

Blood Dyscrasias and Their Relation to Laryngology. Dr. William Dameshek (by invitation), Boston.

Dr. Dameshek discussed a wide variety of blood disturbances associated with throat symptoms. Sideropenic dysphagia is a new term applied to the Plummer-Vinson syndrome, in which lowered iron content leads to changes in the mouth, tongue, and esophagus. Other deficiency diseases mentioned were agranulocytosis and mononucleosis, due to derangement of the white cell system, as well as the blood deficiencies due to various drugs, such as aminopyrine (Amidopyrine), antihistaminics, etc. Other diseases discussed by the author include leukemia, thrombocytic purpura, and vitamin K deficiency, all with various pharyngeal manifestations. Also included in the discussion were hemophilia, periarteritis nodosa, and hereditary telangiectasis.

The author questioned the value of routine preoperative blood studies in ear, nose, and throat surgery, especially with reference to the bleeding and coagulation time. The family and personal histories have proved to be more productive of significant information regarding tendency to bleed.

DISCUSSION

Dr. Robert L. Goodale asked whether Dr. Dameshek had any comment to make on the so-called pseudohemophilia that Dr. Jackson had recently discussed extensively.

Dr. Samuel Salinger corroborated what the essayist had to say about routine coagulation and bleeding time determinations as an index to probable hemorrhage, particularly in T. A. cases. He had done these tests routinely in a large series of cases and found them to be unreliable. Frequently a patient with a normal bleeding and coagulation time would bleed severely, and vice versa. Also, he agreed with the essayist that personal and family histories were of prime importance and should never be neglected.

Dr. Dameshek, replying to Dr. Goodale, stated that hemophilia has in recent years been divided into various groups and subgroups. Pseudohemophilia is a disturbance in which excessive bleeding follows minor trauma and is a distinct entity. It may be of familial origin and can be transmitted by either parent. It does not have the same hereditary patterns as true hemophilia. It is not helped by transfusions, as is hemophilia, and can be combated only through local pressure. It is not a well-defined entity and can be recognized only through the history and increased bleeding time up to 20 minutes.

In regard to routine coagulation and bleeding time determinations, he believes that too much attention has been given them. Capillary tube estimates are worthless. If coagulation time is to be measured, it should be done with siliconized tubes. Bleeding time determinations are very difficult to obtain and require more time and care than routine procedures.

The Use of Staphylococcus Toxoid in Otolaryngology. Dr. French K. Hansel, St. Louis.

According to Hansel, blood disturbances due to some of the newer drugs have been on the increase. Natural immunity is often suppressed by the antibiotics, and residual sinus disease has been observed in children receiving antibiotic therapy. Also, the normal bacterial flora of the gastrointestinal tract have been diminished. Staphylococcus toxoid has been found to be of value in restoring natural immunity. The best results are obtained by giving increasing doses of a high dilution up to the point where local reactions are observed. The optimum dose is that amount which falls just short of evoking this reaction. Injections should be given at two- to four-day intervals. The author is experimenting with the toxoid in the treatment of the common

cold, but has not progressed far enough to permit drawing conclusions. The main burden of Hansel's thesis is the importance of restoring and raising natural immunity through the use of the toxoid.

DISCUSSION

DR. ROBERT L. GOODALE stated that the toxoid had been used at the Massachusetts Eye and Ear Infirmary and that studies had been made on the effects of autogenous vaccines for the same purpose, namely, to stimulate active immunization. The toxoid had not proved to be of much value in a series of conjunctivitis cases. However, seven-hour cultures of Staphylococcus had proved to be useful in vaccines when used in small doses. With regard to the toxoid, he had had no personal experience, but wanted to know more about it. He asked what brand Dr. Hansel used.

DR. FRANCIS W. DAVIDSON agreed with Hansel and Goodale regarding the use of small doses. In principle, one should expect relief in low-grade infections from the use of vaccines, toxoids, or filtrates, if properly applied.

DR. HANSEL closed the discussion by stating that Staphylococcus toxoid is available from three or four commercial houses, being produced under standard conditions. Results may be variable, because of the varied tolerance and reactability of different patients. Other toxoids also may produce the same results as the Staphylococcus, as shown by Dr. Mellen, who obtained immunity from small doses of Streptococcus serum.

The Venous Networks of the Nasal Mucosa. DR. OSCAR V. BATSON, Philadelphia.

Dr. Batson employed a dental acrylic compound as the injection material for corrosion studies of the blood vessels of the nose. The slides he showed demonstrated the rich venous plexuses along the vomer, middle turbinate, and roof of the nasopharynx. There is also a plexus around the nasolacrimal duct, which explains the appearance of a dacryocystitis in infants, due to compression of the duct by the expanded veins. Another interesting plexus is the one in the antrum mucosa converging on the ostium. Also, the plexus of veins on the outside of the vestibule communicates with a similar plexus on the inner side.

A study of these beautiful specimens can add much to the understanding of the sources of nasal hemorrhage as well as the likely pathways for the transmission of infection.

Congenital Anomalies of the Larynx. DR. PAUL H. HOLINGER, DR. KENNETH C. JOHNSTON (by invitation), and DR. FILMORE SCHILLER, Chicago.

Among the congenital anomalies of the larynx described by the authors were congenital stridor, due to flaccidity of the tissues about the introitus, congenital webs (19 cases), congenital stenosis, congenital cysts, and laryngocele. The colored slides which were shown depicted various types of these deformities most graphically. Congenital stridor is usually outgrown, only rarely requiring a tracheotomy. Most congenital webs can be overcome by gradual dilatation. Cysts in the newborn infant can be aspirated for temporary relief and operated on later if they fail to collapse.

DISCUSSION

DR. CHEVALIER L. JACKSON asked Dr. Holinger whether it was his impression that relief in congenital stridor following the introduction of a laryngoscope was due to flattening of the epiglottis. He himself had felt that it was beneficial, yet never accepted it as a proved fact.

DR. GABRIEL TUCKER complimented Dr. Holinger on his beautiful moving pictures. He, like Dr. Jackson, had observed improvement after the introduction of an anterior commissure scope in a recent case of laryngeal stridor. He inquired whether Dr. Holinger had found that turning the child on the face afforded relief in these cases.

DR. HOLINGER, replying to Dr. Jackson's query, stated that he had not found any beneficial therapeutic effect from the mere introduction of a laryngoscope. However, he expects to follow this item more closely in the future.

Indications and Contraindications for Hormonal Therapy. DR. SAM E. ROBERTS, Kansas City, Mo.

Among the contraindications for hormone therapy are the following: malignant hypertension, peptic ulcer, tuberculosis, psychoses, and severe diabetes. Possible side-effects to be watched for are depression of glandular function and atrophy. Frequently the only way in which to

gauge the effectiveness of hormone therapy is by careful clinical trial and observation. Since male and female hormones are combined in both sexes to various degrees, it is frequently necessary to administer both in a given case. Otolaryngological conditions which may be benefited by hormone therapy are asthma, hay fever, perennial allergy, drug allergy, and malignant granuloma. Also, cortisone ointment is helpful in contact dermatitis.

DISCUSSION

DR. FRANCIS L. WEILLE mentioned some work done by Dr. Frazer Lowell, of the Massachusetts Memorial Hospital, in which 25 mg. of cortisone was given four times daily for four days in a group of 75 hay fever patients, yielding 60% cures for the season.

Another group of 23 patients with status asthmaticus were treated with 75 mg. of cortisone daily over a period of many months. Despite the utmost care in watching for side-effects, three patients developed fractures of the spine, probably due to osteoporosis following depressed protein synthesis due to the cortisone. The loss of body calcium results in lowered development of osteoid, which is needed in the production of new bone. Prolonged cortisone therapy is therefore not without danger of serious complications.

DR. ROBERTS had not experienced as good results as those reported by Dr. Goodale. He is fully aware of the dangers of prolonged cortisone therapy and therefore has always interrupted the therapy by periods of rest. Because of loss of calcium and potassium the patient should receive a high protein diet and a high calcium and potassium intake. Patients are weighed every few days, blood pressures taken, and a close watch maintained for fluid retention. In severe asthmatic cases he prefers giving corticotropin (ACTH) intravenously over a period of from four to eight hours, which can be done in the office.

Principles and Problems of Neck Surgery. DR. GRANTLEY W. TAYLOR (by invitation), Boston.

Neck surgery is within the field of several specialties: orthopedic surgery, neurosurgery, plastic surgery, laryngology, thoracic surgery, etc. Thorough understanding of the anatomy is of prime importance, because of the vital structures that traverse this corridor. It is often necessary to have the cooperation of more than one specialist. Among the problems presenting are the question as to whether both internal jugulars can be sacrificed, dangers in ligating the common carotid, methods of dealing with intrinsic carcinoma of the larynx, and the restoration of the esophagus in extensive resections. Technical skill alone is not sufficient. The most important questions to be answered by the surgeon are "How much good am I doing the patient?" and "Have I increased his abilty to live, or have I contributed to his misery?"

DISCUSSION

DR. HENRY B. ORTON agreed that in bilateral neck dissections ligation of the second jugular vein would have to follow at a respectable interval of time, otherwise serious consequences might ensue. Referring to Dr. Wookie's work on lateral pharyngotomy mentioned by Dr. Taylor, Dr. Orton mentioned the fact that this procedure had originally been described by Dr. Trotter, of London, whose work Dr. Orton had personally witnessed back in 1927.

DR. JOEL PRESSMAN requested that Dr. Taylor outline his concept of the type of training necessary for one who would embark on this type of surgery.

DR. OSCAR V. BATSON, commenting on the problem of bilateral jugular ligations, indicated the extremes between the elastic resilient vessels in the young and the restricted vessels in the aged as evidence of the variable compensatory adjustments one may expect under varying conditions. The same applies in a comparison between the sedentary white collar worker and the robust stevedore so far as their respective vascular systems are concerned. The manual laborer develops a more responsive vertical system of veins, which is capable of returning the blood when the upper tributaries are temporarily blocked off. Thus the problem is an individual one capable of wide variations. The same applies to ligation of the common carotid. The question in each case is the procedure versus the patient: how much reduction of minute volume and volume flow through the central nervous system the patient can tolerate. Also, the functional capacity of the heart plays an important role.

DR. FRANCIS L. LEDERER commented on the importance of the specialist's keeping in touch with the general surgeon in matters in which the specialties overlap. It is a subject of deep

interest to those who are engaged in instructing internes and residents. He quoted Dr. Cope's recent statement to the effect that "surgical specialties in their preoccupation with technique have tended to get too far out on the spoke."

DR. TAYLOR closed the discussion by first acknowledging Trotter's priority in this field. His own experience in the preantibiotic days and before the newer techniques in anesthesia were developed was disastrous, which served as a deterrent for a long time or at least until recent developments demonstrated that the margin of safety could be widened considerably.

Dr. Batson's comments were of tremendous value, particularly his emphasis on the vertical veins and their ancillary venous circulation. As to the results of common carotid ligation, it is a matter of common knowledge that the ancillary circulation by way of the external and internal carotid hookup from cross tributaries may be sufficient in many cases. This was well brought out in Mont Reid's work on pulsating aneurysm, which was mentioned in the discussion.

Dr. Pressman and Dr. Lederer brought up the subject of training surgeons for this type of work. It could be a topic for a whole evening's discussion. Recently at the Massachusetts General Hospital all surgical residents were passed through the specialty services. Ideally, it would be best for the surgical specialist to serve a three-year general surgical residency before going into his chosen specialty. Certainly an experience developed in general surgery would be extremely valuable for the prospective specialist for reasons which are all too obvious.

A Study of Lymphoid Tissue of the Nasopharynx. DR. PHILIP E. MELTZER, Boston.

Dr. Meltzer covered many of the problems connected with the lymphatic tissue of the nasopharynx. The true physiology of the adenoid is still not completely understood, but its importance as a factor in the production of nasal and otic symptoms is appreciated by the thoughtful otolaryngologist. Since the conformation of the nasopharynx varies within wide limits, it is obviously impossible to thoroughly remove all the adenoid tissue except by direct vision. Irradiation, while of service in preventing regeneration after surgery, cannot entirely replace the latter. At the Massachusetts Eye and Ear Infirmary x-ray is favored over radium.

It is important in many cases to properly evaluate allergic and endocrine factors, since these have been known to influence the development of the nasopharyngeal lymphoid tissue. Though imperfectly understood, they, nevertheless, offer enough significant proof of a direct relationship to warrant pursuing their therapeutic possibilities within the known limits of safety.

DISCUSSION

DR. FRANCIS W. DAVIDSON mentioned some of the facts recently determined by studies of excised adenoid tissue that were made at his department of bacteriology. The tissue was chewed up in a disintegrator, and serial dilutions and plate cultures were made. The bacteriologic count was as high as 14 million bacteria per gram of adenoid tissue. Large doses of penicillin materially diminished the count. Further studies are in progress.

MR. TERENCE CAWTHORNE reported on the results of an investigation being conducted by the British Medical Research Council into the relative merits of local and distant irradiation. However, the number of cases available for this study was less than anticipated, because the number of children requiring such therapy after surgery was quite small. They have toyed with the idea of employing some of the newer hormones, but he personally has been a bit chary about the possibility of exchanging a few little lymphoid nodules for a luxuriant mustache! Nevertheless, if cautiously employed, the hormones may offer something new and effective in certain cases.

DR. THOMAS C. GALLOWAY called attention to a division of opinion among pediatricians with regard to tonsil and adenoid surgery. There are quite a few who are opposed to surgery because they believe that, first, irradiation can accomplish as much and, second, there is the danger of poliomyelitis. However, the deductions drawn from recent papers on this subject are open to question, and, as the matter stands now, there is no good reason to abandon surgery when properly indicated and carried out.

DR. HENRY L. WILLIAMS called attention to Wilhelm Meyer's work in 1864, emphasizing the importance of the adenoids over and above the tonsils. Dr. Meltzer has reemphasized this point. An interesting fact in connection with Meyer's work was that the procedure was carried out without anesthesia, the patient being held upright, with the head forward. Although he personally does not favor this position, he knows that it is still employed in some quarters despite general anesthesia.

DR. WALTER J. THEOBALD emphasized the importance of good visualization of the epipharynx, and for this reason has found the Yankauer speculum to be of great value in diagnosis of lesions in this vicinity. Dr. Theobald showed a slide representing a study of the nasopharynx in 150 cases, demonstrating pathology which might otherwise have been overlooked.

DR. ROBERT E. PRIEST reported a case in which a child was treated with radiation, whose hearing was still greatly reduced. Examination revealed a bar of tissue extending from one Eustachian orifice to the other, occluding both. Surgical removal restored the child's hearing to normal.

DR. MELTZER, commenting on Dr. Davidson's report of the bacterial count, stated that the number of bacteria is not so important in pathogenesis as the reaction of the tissues to the particular flora present. The lymphoid tissue may become sensitized, resulting in a local allergic reaction, with persisting edema. He agreed with Cawthorne and Galloway that the decision as to the kind of therapy may at times be difficult, yet the concensus at present still favors surgery. As to the position of the patient undergoing adenoid surgery, it has been shown that the upright posture is more dangerous than the recumbent. This was proved by Mosher, who changed the procedure previously employed in his institution. As for exposure of the nasopharynx, as discussed by Dr. Theobald, he agrees that it is most important. However, he has used the Lathrop or the Love retractor and is satisfied that the exposure is adequate.

Some Practical Considerations Concerning Respiratory Allergy. DR. RICHARD A. KERN (by invitation), Philadelphia.

The allergic person has an inherited defect and general sensitivity which lasts throughout life, while specific sensitivity may be transient, outlived, or cured. Overexposure, trauma, and new environment may develop new sensitivities. New potential allergic inhalants are to be found in urban areas, due to new procedures in manufacturing. The exact offending agent of house dust is unknown, but in every instance the factor is local. Therefore, in order for the treatment to be successful, dust injections should be made from material collected from the immediate environment of the patient. Pyrethrum sensitivity is increasing, due to the extensive use of insecticides, as well as sensitivity to molds.

In perennial allergy, bacterial sensitivity may be a strong factor; the sensitivity involves only certain strains. Therefore testing and therapy should be by autogenous vaccines.

Allergy has a quantitative factor as well as a qualitative: the threshold of reaction varies in different persons. Partial avoidance, therefore, while helpful, cannot hope to be curative. Complete avoidance of the offending allergen, if possible, plus hypersensitization, may build up sufficient resistance to eventually bring about a cure.

Steroids, though helpful in emergencies, must not be given in the hope of a cure. Injudicious use of these agents may have serious consequences. They should be used for short periods of time only in cases such as serum sickness, ivy poisoning, acute dermatitis, and drug reactions.

A Study in Voice Production in Laryngectomized Patients. DR. GORDON D. HOOPLE (by invitation) and DR. DAVID W. BREWER, Syracuse, N. Y.

(Abstract not available.)

DISCUSSION

DR. JULIUS MCCALL offered an explanation of why some of these patients are able to develop an esophageal voice while others are not. Such a voice is the result of the patient's ability to forcibly expel a sufficient amount of air from the pharynx and esophagus synchronous with the necessary movements of the lips, tongue, and teeth. This act can be learned much better before the larynx is removed, because the patient has his glottic valve, by which the respiratory act can be stopped while the belching is carried out. If the patient is trained to control the respiratory act at the right moment, he learns how to dissociate the respiratory mechanism from the pharyngoesophageal effort. A review of 149 laryngectomized patients at St. Luke's Hospital in Cleveland showed that 99 had received such preoperative training and that 67 of these developed a good voice, whereas of 27 who had not received such training, only 13, or 48%, were able to learn the act.

DR. LOUIS H. CLERF has found it helpful for the laryngectomized patient to come into contact with similar patients who have already learned to speak. Also, it is very important to determine just how the air is to be accumulated in the esophagus. He is not in favor of

teaching the patient to swallow the air. It is less objectionable if the patient can learn how to draw the air into the esophagus, which can be voluntarily dilated, as shown in radiographic studies which he made. The air is drawn downward by relaxing the cricopharyngeus muscle as the diaphragm is depressed. The upper part of the inferior constrictor acts as a resonating fold under the impact of the expelled air, which produces the sound.

Dr. Henry B. Orton stated his belief that the voice which is under discussion is really a pharyngeal rather than an esophageal phenomenon. He agreed that the constrictor muscles play a considerable role in the act. The question as to the degree of intelligence of the patient in relation to his ability to develop a new voice, he has found, has no bearing at all on the problem, for he has seen some very illiterate persons display a surprising aptitude for the new procedure, whereas others far more intelligent and educated fail to make progress. It is important also to note that the patient in the beginning cannot try to talk and breathe through the tracheal stoma at the same time. It is therefore helpful to temporarily occlude the opening while the effort at speech is being made.

Pharyngoesophageal Diverticulum and the Otolaryngologist. Dr. Francis E. LeJeune, New Orleans.

Dr. LeJeune presented a summary of his experience with 73 cases of diverticulum, most of which were among older people. The youngest patient was 33, the oldest 78. He showed the anatomical factors which predispose to this condition and discussed the symptoms and diagnosis. The onset is insidious, and in many cases the diverticulum is discovered only in routine examinations. Late symptoms are a sense of obstruction, constriction, regurgitation, gurgling, and retrosternal discomfort. LeJeune prefers a one-stage operation, in which an attempt is made to locate the sac after opening the carotid sheath, dividing the omohyoid, and tying off the vessels. The esophagoscope may be very helpful in outlining the sac and assists in limiting the dissection. The procedure was successful in 36 out of 41 cases thus treated. Complications ensuing were two cases of recurrent paresis, fistula in one case, and stricture in two. All recovered.

DISCUSSION

Dr. Louis H. Clerf agreed with the essayist on the importance of esophagoscopy in addition to x-rays for diagnosis. In one case a carcinoma was found, which meant that a diverticulotomy was not done. This happened also in another case, in which a preliminary esophagoscopy had been omitted. He agreed that the one-stage operation was most desirable. Since the hazards are few, there is no reason why such cases should not be treated surgically, since, otherwise, the patient can anticipate only increasing misery.

With regard to inverting the sac, Dr. Clerf has no objection if the sac is small. However, to invert a large sac would only invite trouble. He has encountered recurrent paresis in 6 cases out of a series of 200. It was on the left side in all patients, and all recovered. Fistula may be avoided by transfixing the sac before amputating it. Also, the danger of stenosis may be avoided by using the esophagoscope before amputating the pouch. The procedure is definitely within the field of laryngology, and it is unfortunate that in some institutions the general surgeon assumes otherwise.

Frontal Sinusitis Treated by External Operation: Complications and Results During a Thirty-Year Period. Dr. Edwin A. Stuart and Dr. William J. McNally, Montreal, Canada.

Drs. Stuart and McNally presented a thorough analysis of a series of 177 frontal sinus operations over a period of 30 years at the Royal Victoria Hospital in Montreal, Canada. This included both acute and chronic cases, in which five different types of operation were employed. There were 22 acute fulminating cases, half of which occurred after the patients had been swimming. Symptoms of intracranial involvement were present in 50% of the cases. Despite osteomyelitis, all but two recovered. The authors discussed the symptoms and indications for surgery and the influence of allergy on the general picture. Commenting on the various techniques designed to maintain the patency of the duct, they stated that exenteration of the anterior ethmoids does not always assure the outcome. Ablation of the sinus was carried out in 23 cases. Chemotherapy has proved extremely valuable in preventing and reducing the incidence of complications.

DISCUSSION

DR. W. LIKELY SIMPSON, drawing on his own experience in 325 ethmosphenofrontal operations, all on private patients in whom he had encountered no complications, emphasized the "do-nothing" attitude in acute cases except in cases of acute frontal osteomyelitis. In such cases one should confine his intervention to removal of the diseased bone and drainage of the abscess, if present, as well as drainage of the sinus. Radical exenteration should not be attempted at this stage. Complications do occur, such as orbital hemorrhage due to rupture of the anterior ethmoid artery, and hemorrhage from trauma to the internal carotid artery was encountered in two cases of sphenoid surgery. He has seen osteomyelitis but never as a result of his surgery. Diplopia is common but usually subsides, although he has had five cases in which it remained permanent. Other complications were one case of ptosis, one of optic atrophy and enophthalmos.

DR. RAULL BERGARA (Buenos Aires, Argentina) called attention to his method of exposing the sinus by a hinged osteoperiosteal flap, cleaning out the sinus and filling it with abdominal fat. He showed some slides which demonstrated complete filling of the sinus, in experimental animals as well as in humans. He is convinced that obliteration is the only sure way of achieving a permanent result and avoiding recurrences.

DR. MCNALLY closed the discussion by stating that his series of cases, although smaller than Dr. Simpson's, nevertheless, were fairly typical of the average clinic. He has been impressed by the differences of opinion among authors with respect to surgical techniques, which suggests that the final solution is still to be had. Dr. Bergara's procedure is very interesting, and the results should be followed with keen interest.

Dr. McNally agreed with Dr. Simpson that acute cases should not be treated with extensive surgery. However, an acute case that fails to respond to conservative treatment may be safely trephined for drainage.

Treatment of Maxillary Tumors Through the Fergusson Approach. DR. ROBERT E. PRIEST, Minneapolis.

The Fergusson approach is similar to Moure's operation but more extensive, being designed for radical extirpation of tumors. The superior maxilla is removed, including the alveolus, lateral nasal wall, and part of the zygoma. The posterior end of the alveolar process is the most difficult to remove, and here the cutting diathermy is used. A map of the area is outlined showing 20 spots, which are numbered for identifying the tissues which are sectioned. The cheek is lined with a split graft and the external wound closed. A packing is left in place for four or five days. This procedure allows for better control of bleeding and minimizes postoperative crusting.

Abstracts from Current Literature

Ear

STUDIES ON THE OTIC LABYRINTH: VI. ANATOMIC EXPLANATION FOR THE HEARING DIP AT 4096 CHARACTERISTIC OF ACOUSTIC TRAUMA AND PRESBYCUSIS. A. C. HILDING, Ann. Otol. Rhin. & Laryng. **62**:950 (Dec.) 1953.

In an effort to determine an explanation for loss of hearing at 4000 to 6000 cps in patients with nerve deafness or acoustic trauma, Hilding dissected the basal turn of five cochleas and inspected them for a better anatomic answer than offered in the past.

He believes that the oscillating compression wave set up in the cochlea from the vestibule forms a jet effect within the basal turn of the cochlea, which causes impact against the outer wall at 6 to 8 mm. from the beginning of the turn. There is a change of direction here, with resultant centrifugal force of equal magnitude directed against the wall at the point of impact. From this point the force would seem to be directed toward the apex and downward toward the basilar membrane and the organ of Corti. At low intensities near threshold, as in ordinary conversation, the pressure effect would be negligible, but at high intensities of sound pressure it could be significant.

If this concept is correct, it would explain the fact that hearing loss in both presbycusis and acoustic trauma is greatest at 4000 to 6000 cps. The force of impact in this area applied a thousand times a second over a period of decades, although only silghtly greater than elsewhere in the cochlea, might serve to stretch and wear the marginal insertion most at this spot. Shock waves from a blast or loud noise, occurring more occasionally, might cause this same type of damage. While the stapedius and tensor tympani muscles contract with noise to protect the cochlea from excessive amplitude, due to their reflex time of about 10 milliseconds, it is still possible for pressure effects to be felt in this short interval. Damage at the point of impact might thus be caused.

STEELE, Kansas City, Kan.

ASPECTS OF HEARING PHYSIOPATHOLOGY DURING THE FIRST POSTOPERATIVE PERIOD FOLLOWING FENESTRATION. G. ZANNOTTI, Ann. Otol. Rhin. & Laryng. **63**:68 (March) 1954.

Zannotti states that audiometric findings, as well as histological and clinical data, indicate that symptoms noted after fenestration of the lateral semicircular canal for otosclerosis cannot be grouped in a single syndrome as an expression of the whole labyrinthine reaction to operative injury.

If it is assumed that the surgical trauma of fenestration is held to a minimum, the impairment of hearing for high frequencies during the initial postoperative period depends on an alteration of sound transmission condition in the middle ear, and not on labyrinthine irritation.

Zannotti states that the concept of postoperative labyrinthitis should be modified as follows: Irritative stimuli normally act on the posterior labyrinth, usually without extension to the anterior labyrinth. This would appear to confirm the relative independence of the two forces of the labyrinth and is of clinical interest, as it allows the surgeon to evaluate surgical injury. It is thus possible, by postoperative audiometry, to establish the extension of trauma and allow prognosis.

If the Weber test is lateralized to the unoperated on ear, if bone conduction is impaired, and if Fowler's test shows recruitment, one may think of labyrinthitis. The immediate postoperative evaluation should not be limited to air-conduction audiometry, as a depression of the high tones may be due either to an alteration of the transmission apparatus or to a labyrinthitis. The author believes that the high-tone loss from the 3rd to the 20th day should depend on mechanical factors, which may be identified as an increase of mass of the new vibrating system, owing to reactive edema of the tympanomeatal flap.

STEELE, Kansas City, Kan.

PROPHYLAXIS OF EXTERNAL OTITIS: PRELIMINARY REPORT. B. H. SENTURIA and C. CARRUTHERS, Ann. Otol. Rhin. & Laryng. **63**:97 (March) 1954.

According to Senturia and Carruthers, the pathogenesis of certain forms of acute and chronic external otitis is as follows: As a result of persistent high temperature and humidity and repeated wetting of the skin by frequent swimming or bathing, there is produced in certain susceptible

persons an edema or thickening of the top layers of the skin of the ear canal. This results in the plugging of the duct of the apocrine and sebaceous glands, and the skin of the ear canals is deprived of its normal protective coating. If the hot, humid period continues and these glands are unable to pour their secretions onto the surface, there develops a preinflammatory state, consisting of an itchy, dry, scaly skin devoid of sufficient lipids. Such skin is constantly irritated by rubbing, scratching, and the introduction of foreign bodies and irritating medication. These are ideal conditions for bacterial growth. Gram-negative bacilli or fungi are readily introduced by fingers, foreign bodies, or contaminated water. None of the bacteriostatic or fungistatic secretions from the epidermal glands are present on the surface of the skin to retard the growth of these exogenous organisms, so that rapid superimposed inflammation results.

The authors are approaching the problem by studying the chemical nature of the normal secretions found in the external auditory canal. If microchemical techniques can be developed for analyzing the essential basic elements in normal secretions, then it will be possible to determine what components are absent in the diseased state which precedes the onset of acute inflammation of the ear canal. Cerumen may well have bacteriocidal or fungicidal properties which maintain the normal healthy physiological and biochemical state of the epidermis. An artificial ear wax has been developed and is now being field tested for the treatment of the itchy, dry, ichthyotic state which precedes the acute inflammation of the skin of the auditory canal.

STEELE, Kansas City, Kan.

TREATMENT OF OTITIS MEDIA AND EXTERNA WITH A NEW ANTIBIOTIC COMBINATION. A. M. LAZAR and M. GOLDIN, Eye, Ear, Nose & Throat Month. **33**:351 (June) 1954.

Proper treatment of infections of the external and middle ears depends upon adequate consideration of the bacteriology. It is important to consider each case individually with appropriate bacteriologic studies and with determination of the sensitivity of the infecting bacteria to various antibiotic or chemotherapeutic agents. Fungi constitute a minor cause of external otitis. Staphylococci or other Gram-positive organisms invariably cause circumscribed otitis externa, whereas Pseudomonas aeruginosa, Proteus vulgaris, and other Gram-negative bacteria are the causative organisms in the diffuse type of otitis externa. Otitis media was formerly considered to be primarily due to Gram-positive bacteria, but studies in recent years indicate that Gram-negative organisms are becoming increasingly more important in this regard. This may be partly due to the increasingly widespread usage of antibiotics which are effective against Gram-positive bacteria, which are then replaced by Gram-negative bacteria.

Because of the wide variety of organisms responsible for ear infections and the marked differences in the sensitivities of these organisms to different therapeutic agents, the ideal medication for treatment of infections of the ear is one that is effective against the widest range of organisms. Lazar and Goldin report on the use of a new drug, Biomydrin Otic, which incorporates neomycin, gramicidin, Thonzonium Bromide, and thonzylamine hydrochloride in an aqueous, isotonic solution buffered at pH 6.2. Neomycin is effective against a very wide spectrum of both Gram-positive and Gram-negative organisms and is particularly effective against infections due to Ps. aeruginosa and staphylococci. Both gramicidin and Thonzonium Bromide are effective against Gram-positive organisms. Thonzylamine hydrochloride exhibits local anesthetic and antipruritic properties. Thonzonium Bromide is also an effective mucolytic agent and a powerful wetting agent.

A total of 282 patients were studied, including 150 children and 132 adults. These cases included four groups: suppurative otitis media, nonsuppurative otitis media, circumscribed otitis externa, and diffuse otitis externa. Treatment was considered to be successful in 88.7%, with only 11.3% considered as failing to respond to treatment. However, successful treatment included both complete cures and moderate to marked improvement. Of the 250 patients classified as successful, only 112, or 45%, obtained complete cures.

Treatment of external otitis consisted in careful cleansing of the canal followed by 4 drops of the drug instilled into the ear three times daily. Treatment of suppurative otitis media consisted in 4 drops of the medication instilled into the ear three times daily, with the flow of the drug facilitated by gentle pressure on the tragus. Usually no other therapy was employed. The superior effectiveness of this ear medication is attributed to its component drugs and to the aqueous vehicle properly adjusted to the correct, slightly acid reaction.

JENNES, Waterbury, Conn.

OBSERVATIONS UPON THE EFFECTS OF REPEATED STIMULATION UPON ROTATIONAL AND CALORIC NYSTAGMUS. J. D. HOOD and C. R. PFALTZ, J. Physiol. **124**:130 (April) 1954.

1. Rabbits were subjected to repeated angular accelerations of low intensity at intervals varying from one minute to one week. Records were made of the resulting nystagmic responses.

2. The nystagmic responses were shown to undergo a marked decline, termed for convenience the R. D. (response decline) phenomenon.

3. The development of the R. D. phenomenon was found to be dependent upon the number of stimuli applied and not upon the interval between them.

4. The R. D. phenomenon was unaccompanied by any change in the latent period of the nystagmic response.

5. The R. D. phenomenon was not found to develop if the stimuli were applied when the rabbits were under light anesthesia. Its mechanism was therefore thought likely to depend upon some central process involving consciousness and allied, in all probability, to that of habituation, as described by Thorpe (1950).

6. The nystagmic responses to repeated caloric stimuli of comparable intensity were not found to exhibit any significant decline.

7. The nervous mechanism of the R. D. phenomenon and the finding that it affects rotational but not caloric nystagmus are briefly discussed.

AUTHORS' SUMMARY.

MODIFIED PORTMANN OPERATION ON THE ENDOLYMPHATIC SAC FOR TREATMENT OF MÉNIÈRE'S DISEASE. K. YAMAKAWA and T. NAITO, Otolaryngology (Tokyo) **26**:7 (Jan.) 1954.

Portmann's operation on the saccus endolymphaticus has closed the fenestra in some instances and failed its objective. To overcome this complication, Yamakawa and Naito recorded their modification on this procedure.

The operation is performed by a postauricular approach, as in the classic Schwartz mastoidectomy. When the saccus is identified, an inverted L-shaped incision is made in the dura over the cerebellum, next to the sac. This dural flap is lifted so as to gain an access to the sac on the cerebellar side. When a window is cut out from the wall of the saccus, there is a free flow of the endolymph, but usually within five minutes it ceases to run. The incised flap of the dura is then replaced and sutured.

The authors operated on 12 patients with Ménière's disease, 8 of whom obtained complete relief from tinnitus and vertigo without sacrificing the sense of hearing, and 4 improved. The operative technique is shown by several drawings.

HARA, Los Angeles.

HERPES ZOSTER OTICUS WITH CONCOMITANT DISTURBANCES IN THE FIFTH, SEVENTH, EIGHTH, TENTH, AND TWELFTH CRANIAL NERVES. A. KAWAOKA and K. ISHIKAWA, Otolaryngology (Tokyo) **26**:23 (Feb.) 1954.

Thirty-three cases of herpes zoster oticus have been reported in the Japanese literature. Kawaoka and Ishikawa add another case of their own, which developed simultaneous lesions in the 5th, 7th, 8th, 10th, and 12th cranial nerves.

The patient was a 55-year-old man. The initial symptoms were left hemicrania, double vision, dysphagia, and hoarseness. On admission to the hospital, the patient presented a typical left Ramsay Hunt's syndrome. There were facial palsy, hepatic lesions of the tympanum and the external auditory canal, impairment of the low-tone perception, and complete loss of caloric response on vestibular stimulation on his left ear. There was sagging of the left half of the soft palate, hemiparesis of the tongue, and left vocal cord paralysis. There was a marked increase in lymphocytes in his spinal fluid. The patient was placed on chlortetracycline (Aureomycin) by mouth and vitamin B_1 intrathecally, and showed a marked response.

HARA, Los Angeles.

Pharynx

LYMPHOSARCOMA OF THE TONSIL IN CHILDREN. BATES F. METSON, Ann. Otol. Rhin. & Laryng. **63**:193 (March) 1954.

Metson reviews the literature on lymphosarcoma of the tonsil in children, finding six cases. All the reported patients were male children, and all died within a few weeks to four months after the diagnosis of lymphosarcoma was made. The author reports a case of his own occurring in a girl 2½ years of age.

The histopathologic diagnosis of lymphosarcoma of the tonsil presents difficult differentiation from highly anaplastic squamous-cell carcinoma. Also, it is difficult to classify the lesion as to type of sarcoma from tissue study alone.

Clinically, when unilateral tonsillar enlargement or marked asymmetry of the tonsils is encountered, one should give ample consideration to malignancy in the differential diagnosis. The suspicion of malignancy should not be discarded after one negative biopsy, as this is a fairly common misleading occurrence in lymphosarcoma of the tonsil.

The treatment of the author's patient was the same as that given in most of the cases previously reported, namely, tonsillectomy followed by roentgen therapy. The outcome was fatal in spite of response of the local pathologic lesion to treatment. This was likewise true in the reported cases.

STEELE, Kansas City, Kan.

SOME TONSIL PROBLEMS. C. J. HEINBERG, Eye, Ear, Nose & Throat Month. **33**:470 (Aug.) 1954.

Tonsillectomy-adenoidectomy should not be considered as a minor procedure because of the possible hazards involved. In young children there is also the risk of undesirable personality changes subsequent to hospitalization and the operation. It is helpful to describe to the child the hospital environment and the anesthetic at the office prior to hospitalization. Heinberg prefers vinyl ether induction, followed by ether vapor, for children, with maintenance in the second plane of anesthesia. The patient does not leave the operating-room table until all reflexes have completely returned. In adults preoperative sedation of morphine and atropine is used, and for local anesthesia Heinberg uses 2% procaine hydrochloride (Novocain) with hyaluronidase and epinephrine. For general anesthesia he prefers induction with cyclopropane with a change over to ether or, in some cases, a very light thiopental (Pentothal) sodium anesthesia combined with local procaine hydrochloride. All operations are performed with patients in the supine position. Immediate hemorrhage is controlled by clamping and tying all bleeding vessels. A combination of rutin and ascorbic acid is used in order to decrease the incidence and amount of bleeding, both immediate and late. Heinberg is of the opinion that tonsillectomy and adenoidectomy can be safely performed during the so-called "polio season" except in the presence of an active epidemic.

JENNES, Waterbury, Conn.

A REVIEW OF 1,000 CONSECUTIVE CLOSED FOSSA TONSILLECTOMIES WITHOUT SPONTANEOUS HEMORRHAGE. ERNEST B. EMERSON JR., New York J. Med. **54**:2339 (Aug. 15) 1954.

Emerson, from the University of Rochester School of Medicine and Dentistry, describes his technique for preventing late hemorrhage after tonsil removal. He says that there has been a general refusal of tonsil surgeons to recognize that bleeding is due to "a hole in a blood vessel not enclosed in a suture." He ridicules such "causes" as spring of the year, menstruation, temperature, etc. This is his second report; the first covered 624 cases published in the *Journal of the American Medical Association* May 24, 1952. He uses blunt dissection and avoids the tonsillotome because of "tags" left behind. Sutures are placed in the tonsil bed and are so set as to take in muscle but to avoid the pillars. Since the blood vessels follow the axis "from pole to pole," all sutures, theoretically at least, surround the vessels and ligate them. Thus the fossa is narrowed or "closed," according to Emerson's terminology. A perfect score was obtained in these 1,000 cases.

ABSTRACTOR'S COMMENT: Bleeding arteries during tonsil surgery have been clamped and tied by all good operators for many years, yet in some cases a slough may open a blood vessel as late as the 13th day (personal experience). Moreover, there are instances of diffuse capillary or small artery bleeding in which styptics and compression are necessary. Also, certain blood dyscrasias, e. g., hemophilia, are responsible for poor clotting and healing time. As for "tabs," they occur under any technique, and must be removed. In these days no tonsillectomist will allow a patient to leave the operating room until all bleeding has stopped.

I. W. VOORHEES, New York.

Larynx

TREATMENT OF BLEEDING ESOPHAGEAL VARICES WITH BALLOON TAMPONAGE. ARTHUR H. BLAKEMORE, New York J. Med. **54**:2057 (July 15) 1954.

Blakemore reports his experiences from the Department of Surgery, Columbia University College of Physicians and Surgeons in association with Presbyterian Hospital.

The esophagoscopist is sometimes called in cases of severe bleeding from the gastrointestinal tract (hematemesis). In the presence of an effusion of blood and virtually no visibility, he may be called upon to check the hemorrhage. Blakemore goes thoroughly into the causes of such bleeding. Commonly there is disease of the liver (cirrhosis) and increased venous pressure in the portal system, with clotting dyscrasias. In the presence of portal hypertension, collateral veins are expanded between the coronary veins of the stomach and the esophagus. They begin to enlarge, become varicose, and may suddenly rupture. Trauma of food passing through or coughing may start such hemorrhage. Moreover, in cirrhosis, formation of prothrombin may be severely curtailed. Therefore every factor militates against cessation of hemorrhage. Shock may come fairly early after severe hemorrhage. Therefore transfusions of whole blood or plasma or an "expander" become imperative. When the blood volume and blood pressure are increased, there is increased hemorrhage; therefore, a vicious circle is established, which requires supreme management. At the locus of esophageal varices, one may pack with absorbable gauze, to obtain pressure, or use balloon tamponage or do an esophagotomy with suture of the veins.

This kind of packing has its drawbacks, just as it has in E.N.T. work. Blakemore does not favor it.

However, with all these maneuvers, one is still in trouble if liver function continues to be disturbed by poor blood circulation. For one thing, there is anoxia, with deterioration of liver cells.

Blakemore restricts this report chiefly to the use of balloon pressure. This should work well, but too often the rubber expandable bag will dilate unequally or "pouch." Then the bag sacculates, producing intragastric pressure instead of intraesophageal. To circumvent this, a balloon has been prepared with reinforcement at the gastric level, so that sacculation is reduced to a minimum. Thus 60 cc. of air inflation may do better than 400 cc. in an uninforced balloon. There is much more to the problem of interest to the internist, but what the direct tube specialist must know is how to stop the bleeding and keep it stopped! First the balloon must be long enough to completely cover the varix-bearing area of the esophagus. The diameter of the balloon before it is inflated must be about that of the esophagus. The rubber balloon wall must be thick enough to withstand a pressure somewhat above that of the portal circulation, which is likely to be around 44 mm. of mercury. Blood must be aspirated from the stomach. This may not be easy if the blood is clotted. A balloon may be left in situ for 72 hours, but Blakemore recommends five-minute releases at six- to eight-hour intervals. It should be remembered that a rubber balloon is a foreign body, and, therefore, ulceration of the esophagus is a hazard. Snell, of the Mayo Clinic, is quoted as having said that some 20% of the patients survive one year after the first bleeding and that the other 80% die.

Blakemore runs his rubber piping through the nose. He says nothing about obstructions, such as septal deviations, polypi, etc. Upon removal of the balloon-tube assembly, another must be ready to be inserted if hemorrhage occurs. This is a well-studied *Arbeit* and is worthy of a careful reading by any physician who has ever seen this type of hemorrhage making exit through nose and mouth.

I. W. VOORHEES, New York.

Nose

THE PARTIAL SADDLE NOSE: A SIMPLIFIED TECHNIQUE WITHOUT THE USE OF IMPLANTS OR TRANSPLANTS. M. WOLFE, Eye, Ear, Nose & Throat Month. **33**:414 (July) 1954.

Wolfe divides partial saddle deformities into two types: in the first type there is a slight saddling, due to a prominent tip, or an exaggerated retroussé nose, which he considers to be usually congenital in origin, and in the second type both a hump and a depression are present, which he fells are nearly always traumatic in origin. The first type is corrected by lowering the projection of the tip of the nose. The second type is corrected by hump removal, with lateral and medial osteotomies and finger fracturing of the nasal bones. Shortening of the nose is performed as indicated. The author finds that after these steps are followed the cartilaginous depression is no longer present.

JENNES, Waterbury, Conn.

PREOPERATIVE MANAGEMENT IN RHINOPLASTY. S. H. GIDOLL, Eye, Ear, Nose & Throat Month. **33**:465 (Aug.) 1954.

The classic submucous resection of the nasal septum is not adequate for correction of certain deformities involving the cartilaginous septum. When the cartilaginous deformity is accompanied by twisted upper lateral nasal cartilages, it is necessary to restore the symmetry of the nasal

dorsum in order to adequately correct the septal deformity. The etiologic factor is frequently a nasal injury incurred in childhood, with accentuation of the irregularities due to growth during adolescence. Gidoll performs the classic submucous resection for septal deflections in the posterior two-thirds of the nose and performs a submucous resection plus a modified rhinoplasty when the deviation is in the anterior third of the nose. He offers the term "septoplasty," which was first suggested by Stovin for this combined operation. Operations such as this are best performed by the rhinologist with reconstructive surgical experience, because the rhinologist alone has the necessary knowledge of nasal physiology.

Careful preoperative preparation of the patient will eliminate the majority of possible complications or untoward sequelae. Patients should be carefully selected and should have a complete physical examination with a routine urinalysis and complete blood cell count. Vitamin K should be administered for three days before operation and for one week after operation. Prophylactic antibiotic therapy starting 24 hours before operation and continuing for three to five days after operation will prevent local infection and promote more rapid postoperative healing. The routine use of cortisone starting the evening before operation and continuing for two days after operation, as suggested by Goldman, Freeman, and Bloom, minimizes postoperative ecchymosis and edema. Adequate preoperative sedation is essential. Gidoll adds hyaluronidase to the solution of procaine hydrochloride (Novocain) and epinephrine in order to promote more rapid diffusion and absorption of the solution and to prevent puffiness of the soft tissues of the nose, with loss of definition of the normal landmarks.

Proper attention to preoperative management in rhinoplasty, with the absence of postoperative edema and ecchymosis and with freedom from discomfort or pain, will result in an improved patient reception of the operation. Trauma is diminished, and healing is not delayed; and it is therefore practicable to perform a submucous resection simultaneously with a rhinoplastic procedure.

JENNES, Waterbury, Conn.

SURGERY OF OZENA. A. LEWKOWITZ, Oto-laryng. israel. **3**:66, 1953.

Lewkowitz uses the Hinsberg technique for the surgical treatment of ozena. The principle is based upon the narrowing of both halves of the nose by shifting the lateral nasal walls medially toward the septum. The author has operated on 223 cases with this technique, and reports that all were cured or greatly improved. The shifted nasal walls are maintained in their new position by the use of a special clip designed by the author, which he removes on the 11th postoperative day.

JENNES, Waterbury, Conn.

Miscellaneous

THE INARTICULATE CHILD: A PROBLEM IN DIAGNOSIS. J. W. MCLAURIN, Laryngoscope **64**:454 (June) 1954.

There are several reasons, in addition to deafness, why a child may be inarticulate. He may be aphasic because of brain damage, he may have a psychic block, or there may be a functional cause. A great responsibility rests upon the physician to recognize the condition, for early treatment is most important.

The intricate tests, such as psychogalvanic skin resistance, audiometry, electroencephalography, and pure-tone audiometry by peep-show methods, are difficult to perform, require elaborate apparatus, special training to operate, and cannot well be used on very young children.

McLaurin considers it unfortunate that the impression that such methods are necessary for diagnosis is so prevalent. The otologist should know the detailed speech and hearing and other developmental stages of the normal child. These stages are explained. If there is no speech (single words) at 12 months or no response to sound at 16 months, there probably is an abnormality.

To diagnose a child's hearing loss there must be a very complete history, the details of which are given. The child is observed carefully, making every effort to put the child at ease. Calibrated noise makers are generally used while the child plays. The cessation of a child's activity is used as the indication of the child's being conscious of the sound. There must be observation of the child's facial expression, use of gestures, motor behavior, social perception, and other characteristics. These not only help to evaluate the hearing loss but also to differentiate it from other lesions.

HITSCHLER, Philadelphia.

News and Comment

SCIENTIFIC EXHIBITS

The A. M. A. ARCHIVES OF OTOLARYNGOLOGY is pleased to introduce in this issue a new feature called "Scientific Exhibits."

This feature attempts to preserve in more permanent form some of the instructive Scientific Exhibits that are presented at the Annual Meetings of the American Medical Association. Although thousands of physicians attend the Annual Meetings, viewing and studying the scientific exhibits at first hand, other thousands are unable to attend. For the first time, the latter group is now given the opportunity to see the exhibits reproduced in the pages of the various A. M. A. Specialty Journals.

While it is at present impossible to publish all the Scientific Exhibits presented at each Annual Meeting of the American Medical Association, it is feasible to select a representative few for the purpose of introducing the new feature to the readers of this periodical. Should "Scientific Exhibits" be well received, it is planned to expand the new department in future issues of the A. M. A. ARCHIVES OF OTOLARYNGOLOGY.

CORRECTION

In the article, "Ménière's Disease Treated by Portmann's Operation," by C. S. Hallpike and M. Spencer Harrison in the August, 1954, issue of the ARCHIVES "any" in the last line of the first column on page 143 should have been "many." The complete sentence should read as follows: "One of the difficulties here has been the fact that it has not been possible in many of the temporal bones which have so far been examined to demonstrate definite changes in the hair cells."

Directory of Otolaryngological Societies *

FOREIGN AND INTERNATIONAL

Canadian Otolaryngological Society
(Société Canadienne d'Otolaryngologie)

President: Dr. G. Edward Tremble, 1390 Sherbrooke St. West, Montreal, P. Q.
Secretary: Dr. G. Arnold Henry, 170 St. George St., Toronto.
Place: Bigwin Inn, Lake of Bays, Muskoka, Ont. Time: June 16-18, 1955.

International Bronchoesophagological Society

President: Dr. André Soulas, 184 Avenue Victor Hugo, Paris 16.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.

International Congress of Audiology

Place: Leyden, Netherlands.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

International Course in Paedo-Audiology

Place: Groningen, Netherlands.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

Pan-American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

President: Dr. Juan Manuel Tato, Azcuenaga 235, Buenos Aires, Argentina.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Meeting: Fifth Pan-American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology.
Place: San Juan, Puerto Rico. Time: February, 1956.
President of Congress: Dr. Juan H. Font, Medical Arts Building, San Juan.

Sixth International Congress of Otolaryngology

President: Dr. Arthur W. Proetz, 3720 Washington Blvd., St. Louis.
General Secretary: Dr. Paul H. Holinger, 700 N. Michigan Ave., Chicago 11.
Place: Hotel Statler, Washington, D. C. Time: May 5-10, 1957.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Francis W. Davison, Geisinger, Memorial Hospital, Danville, Pa.
Secretary: Dr. Hugh A. R. Kuhn, 112 Rimbach St., Hammond, Ind.
Place: Atlantic City, N. J. Time: June 6-10, 1955.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Walter H. Theobald, 307 N. Michigan Blvd., Chicago 1.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave. Bldg., Rochester, Minn.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

American Board of Otolaryngology

President: Dr. Frederick T. Hill, Professional Building, Waterville, Maine.
Secretary-Treasurer: Dr. Dean M. Lierle, University Hospitals, Iowa City.
Examinations: Hotel Marshall, Richmond, Va., March 6-10, 1955; Palmer House, Chicago, October, 1955.

American Broncho-Esophagological Association

President: Dr. Clyde A. Heatly, 11 N. Goodman St., Rochester, N. Y.
Secretary: Dr. F. Johnson Putney, 1719 Rittenhouse Sq., Philadelphia 3.
Place: Hollywood Beach Hotel, Hollywood, Fla. Time: March 15-16, 1955 (afternoons only).

American Laryngological Association

President: Dr. Henry B. Orton, 224 Delavan Ave., Newark 4, N. J.
Secretary: Dr. Harry P. Schenck, 326 S. 19th St., Philadelphia 3.
Place: Hollywood Beach Hotel, Hollywood, Fla. Time: March 13-14, 1955.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Kenneth M. Day, 121 University Place, Pittsburgh.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester 7, N. Y.
Place: Hollywood Beach Hotel, Hollywood, Fla. Time: March 15-16, 1955 (mornings only).

SECTIONS:

Eastern.—Chairman: Dr. Benjamin H. Shuster, 1824 Pine St., Philadelphia 3.
Place: Hotel Warwick, Philadelphia. Time: Jan. 7, 1955.

Southern.—Chairman: Dr. G. Slaughter Fitz-Hugh, 104 E. Market St., Charlottesville, Va.
Place: Medical School Auditorium, Charlottesville, Va. Time: Jan. 22, 1955.

Middle.—Chairman: Dr. James E. Croushore, 3001 W. Grand Blvd., Detroit.
Place: Sheraton-Cadillac Hotel, Detroit. Time: Jan. 24, 1955.

Western.—Chairman: Dr. Victor Goodhill, 2007 Wilshire Blvd., Los Angeles.
Place: The Town House, Los Angeles. Time: Jan. 15-16, 1955.

American Otological Society, Inc.

President: Dr. D. E. Staunton Wishart, 170 St. George St., Toronto 5, Canada.
Secretary-Treasurer: Dr. John R. Lindsay, 950 E. 59th St., Chicago 37.
Place: Hollywood Beach Hotel, Hollywood, Fla. Time: March 17 (afternoon), 18 (forenoon and afternoon), and 19 (forenoon), 1955.

American Otorhinologic Society for the Advancement of Plastic and Reconstructive Surgery, Inc.

President: Dr. Matthew S. Ersner, 1915 Spruce St., Philadelphia 3.
Secretary: Dr. Louis Joel Feit, 66 Park Ave., New York 16.

American Society of Ophthalmologic and Otolaryngologic Allergy

President: Dr. F. Lambert McGannon, 14595 Madison Ave., Lakewood, Ohio.
Secretary-Treasurer: Dr. Michael H. Barone, 468 Delaware Ave., Buffalo 2.
Place: Palmer House, Chicago. Time: 1955.

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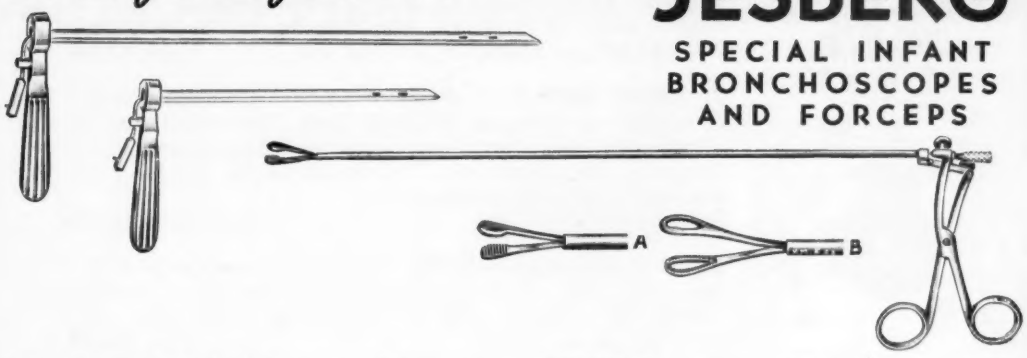

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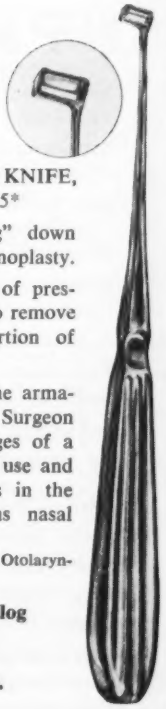

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* See page 508, A. M. A. Archives of Otolaryngology, October 1954.

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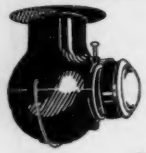

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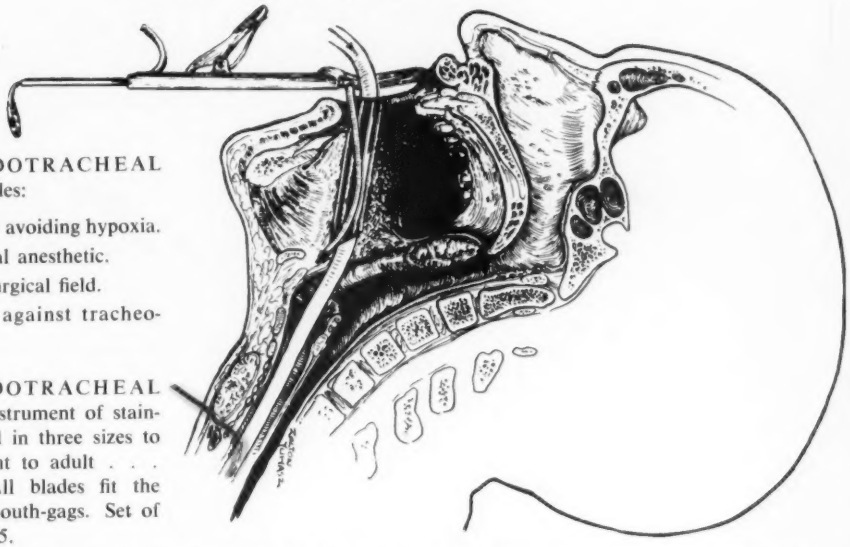

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*Barton, R. T.: Instrument for endotracheal anesthesia during oro-pharyngeal surgery. J. A. M. A. 153:1017 (Nov. 14) 1953.

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